

**UNITED STATES
DEPARTMENT OF
AGRICULTURE**

**RURAL DEVELOPMENT
UTILITIES PROGRAMS
ELECTRIC PROGRAM**

**2006 ELECTRIC
ENGINEERING SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

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2006 ELECTRIC ENGINEERING SEMINAR

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**2006 ELECTRIC ENGINEERING
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Publications and Website Update

**Harvey Bowles, Chair
Technical Standards Committee “A”**

BIOGRAPHICAL SKETCH

Harvey L. Bowles

Mr. Bowles received his BS in Electrical Engineering from Virginia Tech in 1973. He joined the Rural Electrification Administration in 1976 as an engineer in the Distribution Branch of what is now the Electric Staff Division. From November 1991 to May 1997, he served as Chairman of Technical Standards Committee "A" (Electric). In November 1995, he returned to the Distribution Branch as the Branch Chief. He was reassigned to the position of Senior Electrical Engineer in September 1999 and his duties include those of Chairman of Technical Standards Committee "A" (Electric) and Electric Program webmaster.

Mr. Bowles has served on a number of industry committees, including the IEEE Switchgear Committee, the IEEE Insulated Conductors Committee, and the Rural Electric Power Committee. In addition he has served as the RUS liaison to various subcommittees of the NRECA T&D Engineering Committee. He is also a registered professional engineer in the Commonwealth of Virginia.



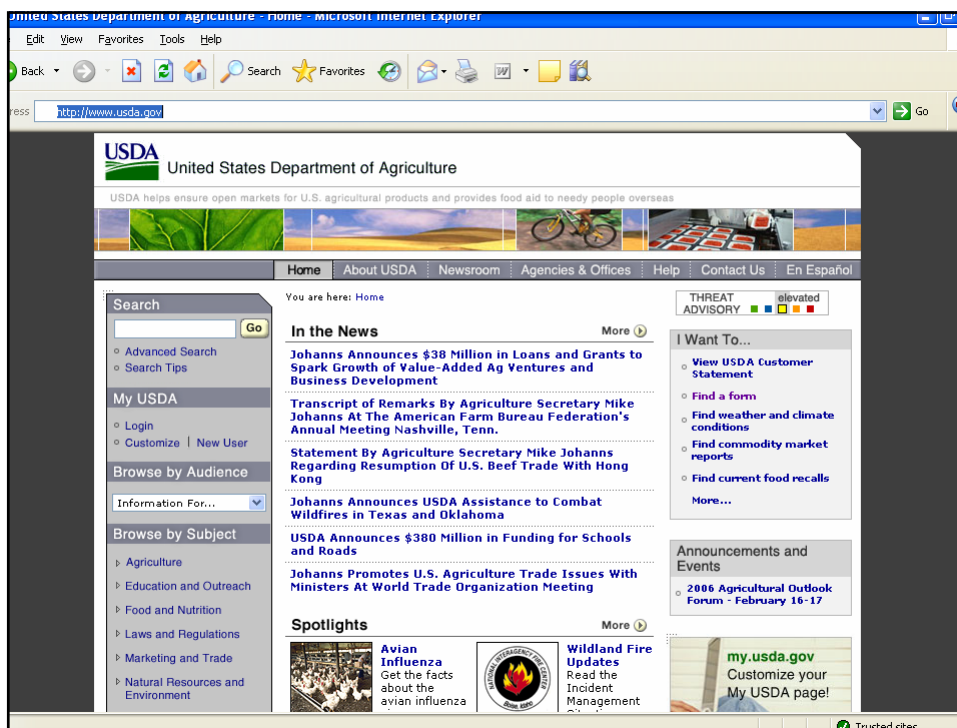
Publications & Website Update



Upcoming Changes to Website

- Will be adopting the look and feel of USDA.GOV





Availability of Publications

- Website – <http://www.usda.gov/rus/electric>
- Not available in hardcopy

Mailing List



Sign up for
eMail News and Information
From the
USDA Rural Development
Electric Programs
<http://www.rdlist.sc.egov.usda.gov>



Regulations Issued

- **7 CFR 1726**, Revision of Electric Program Standard Contract Forms (2/13/04)
 - Bulletin 1726I-602, Contract Attachments (2/19/2004)
- **7 CFR 1726**, Revision of Electric Program Standard Contract Forms (8/27/04).
 - Forms 198 & 211



Regulations Issued

- **Bulletin 1728F-804**, Specifications and Standards for 12.47/7.2 kV Line Construction” (Incorporated by Reference – 4/21/2005)
- **7 CFR 1792**, Seismic Safety (Direct Final Rule – 6/1/2004)



Informational Publications Issued

- **IP 202-1**, List of Materials (updated frequently)



Bulletins Issued

- **Bulletin 1724D-106**, Considerations For Replacing Storm-Damaged Conductors (6/1/2005)
- **Bulletin 1724E-200**, Design Manual for High Voltage Transmission Lines (9/23/2004) (with May 2005 revisions)
- **Bulletin 1724E-220**, Procurement and Application Guide for Non-Ceramic Composite Insulators, Voltage Class 34.5 kV and Above (3/17/2005)



Bulletins Issued

- **Bulletin 1728F-804**, Specifications and Drawings for 12.5/7.2 kV Line Construction (4/21/2005)
- **Bulletin 1730B-2**, Guide for Electric System Emergency Restoration Plan (1/7/2005) (includes revised page 20 - 3/1/2005)



Very Soon!

- **Bulletin 1724D-101**, Electric System Long-Range Planning Guide
- **Bulletin 1728F-800**, Distribution Assembly Numbers and Standard Format



Work in Progress

- **Bulletin 1724D-113**, Voltage Levels on Rural Distribution Systems
- **Bulletin 1724D-114**, Voltage Regulator Application on Rural Distribution Systems
- **Bulletin 1724E-220C**, Transmission Line Clearances



Work in Progress

- **Bulletin 1728F-803**, Specifications and Drawings for 14.4/24.9 kV Line Construction
- **Spec U-1**, Primary Underground Cable
- **Bulletin 1728F-700**, Specification for Wood Poles, Stubs and Anchor Logs



Work in Progress

- **Bulletin 1728H-701**, Specification for Wood Crossarms, Transmission Timbers and Pole Keys (7 CFR 1728.201)
- **Bulletin 1728H-702**, Specification for Quality Control and Inspection of Timber Products (7 CFR 1728.202).



Work in Progress

- **Bulletin 1730A-119**, Interruption Reporting and Service Continuity Objectives for Electric Distribution Systems



**2006 ELECTRIC ENGINEERING
SEMINAR**

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**National Electrical
Safety Code Revisions**

**H. Robert Lash, Chief
Transmission Branch**

**Electric Program
NESC Subcommittee Members**

BIOGRAPHICAL SKETCHES

H. Robert Lash

Bob Lash is presently the Chief of the Transmission Branch, Electric Staff Division. In this position he supervises the review of transmission line designs, substation designs, contract and policy review and revision, and other technical areas of support for the area offices. Bob is a member of IEEE, and American Wood Preservers' Association and sits on several ANSI subcommittees. Prior to joining RUS in 1983, Bob was employed by Burns & McDonnell Consultants and Joslyn Manufacturing. He graduated from Kent State University in 1980 with a MBA and SUNY College of Environmental Science and Forestry in 1974 with a BS in Wood Products Engineering.

Harvey Bowles

Mr. Bowles received his BS in Electrical Engineering from Virginia Tech in 1973. He joined the Rural Electrification Administration in 1976 as an engineer in the Distribution Branch of what is now the Electric Staff Division. From November 1991 to May 1997, he served as Chairman of Technical Standards Committee "A" (Electric). In November 1995, he returned to the Distribution Branch as the Branch Chief. He was reassigned to the position of Senior Electrical Engineer in September 1999 and his duties include those of Chairman of Technical Standards Committee "A" (Electric) and Electric Program webmaster.

Mr. Bowles has served on a number of industry committees, including the IEEE Switchgear Committee, the IEEE Insulated Conductors Committee, and the Rural Electric Power Committee. In addition he has served as the RUS liaison to various subcommittees of the NRECA T&D Engineering Committee. He is also a registered professional engineer in the Commonwealth of Virginia.

Jim Bohlk

In his 15 years at RUS, Jim has been the lead engineer in updating the overhead distribution construction standards and several new distribution guide bulletins. Before coming to RUS, Jim was a distribution engineer at an investor owned electric utility and a system engineer at an electric cooperative in Michigan.

Donald Heald

Donald Heald is a structural engineer employed in the Electric Staff Division of the Rural Utilities Service. For the past 30 years, he has been working in the Transmission Branch of the Electric Staff Division in developing agency recommendation, guidelines, and standards for use by RUS engineers, borrowers, and consulting engineers. He is active in transmission related committees and working groups in IEEE and represents RUS on the Strengths and Loadings Subcommittee of the NESC. Mr. Heald graduated from Virginia Tech in Civil Engineering in 1972 where he later received his masters.

Trung Hiu

Mr. Trung Hiu is an electrical engineer and serves as the Underground Distribution Engineer in the Electric Staff Division at RUS. Mr. Hiu graduated from Virginia Tech in 1992. He has been with RUS for over ten years. His primary responsibilities include revising and updating the RUS Bulletin D-806, "Specifications and Drawings for Underground Electric Distribution" and the U-1, "Specification for 15 kV and 25 kV Primary Underground Power Cable." His area of specialty is URD Cables. He represents RUS at the ICC (Insulated Conductors Committee) Meetings, the ANSI Z535 Committee for safety signs, and the Subcommittee 7, Underground Lines, of the NESC (National Electrical Safety Code.)

*RUS 2006
Electric Engineering Seminar
Orlando, Florida*

National Electrical Safety Code Revisions

*Bob Lash, Chief, Transmission Branch,
and RUS NESC Subcommittee Members*



Development of NESC Change Proposals

- *Change Proposals are submitted by individuals or organizations*
- *Task forces are established by NESC subcommittees to develop change proposals*
- *The subcommittee may develop a change proposal as a result of an interpretation request*

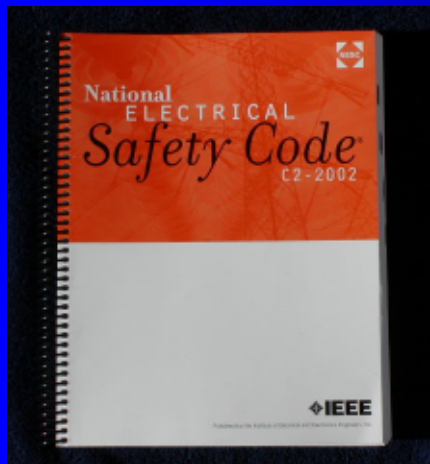


REASONS FOR CHANGE PROPOSALS

- *To address a safety issue*
- *To respond to an interpretation request*
- *To clarify a sentence or section*
- *To update the code to current national standards*
- *To update the code to new materials*



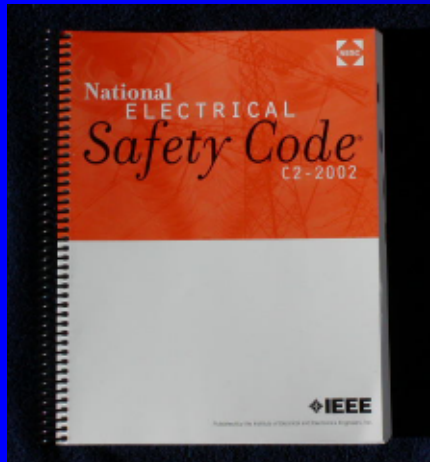
Proposed Changes to the 2002 NESC for the 2007 NESC



- *Comments from the public received by
May, 2005*
- *Final Vote by
Subcommittees
Oct, 2005*



Proposed Changes to the 2002 NESC for the 2007 NESC



- Aug 1, 2006
publication of
NESC 2007
- Jan, 2007 NESC
2007 becomes
effective



Useful Links.....



- *NESC Committee information*
<http://grouper.ieee.org/groups/nesc/>
- *Interpretation Requests from 1991*
<http://standards.ieee.org/nesc/interpretations.html>
- *NESC Revision Schedule*
<http://standards.ieee.org/faqs/NESCFAQ.html#q4>
- *NESC Tentative Interim Amendments*
<http://grouper.ieee.org/groups/nesc/index.html#tia>
- *NESC Errata's*
<http://grouper.ieee.org/groups/nesc/index.html#errata>

List of NESC Subcommittees

- SC 1 Purpose, Scope, Application, Definitions, and References
- SC2 Grounding Methods.....Harvey Bowles
- SC3 Electric Supply Stations
- SC4 Overhead Lines – Clearances....Jim Bohlk
- SC5 Overhead Lines – Strengths and Loadings.....Donald Heald
- SC7 Underground Lines.....Trung Hiu
- SC8 Work Rules
- Executive Subcommittee



Subcommittee 2 Grounding Methods

Harvey Bowles



Subcommittee 2 – Grounding Methods

- Rule 094B2 - Iron or steel rods shall have a cross-sectional dimension of **not less than** 15 mm (5/8 in).
- Rule 017B - The dimensions of physical items referenced in this code, such as wires and ground rods, are “**nominal values**” assigned for the purpose of convenient designation.



Subcommittee 2 – Grounding Methods

- SC2 requested that SC1 modify Rule 017B, by removing the words “ground rods” from the Rule, which would essentially make ground rod dimensions actual.
- SC1 accepted the request from SC2.



Subcommittee 2 – Grounding Methods

- At its September 2005 meeting, SC2 was informed by members of NEMA's 8CC technical committee that GR-1 (standard for ground rods) was being revised to require 5/8" galvanized rods to be a minimum of 0.625 inches in diameter.



Subcommittee 2 – Grounding Methods

- Rule 092D - Added paragraph and footnote
 - “Under normal system conditions a grounding conductor current will be considered objectionable if the electrical or communication system's owner/operator deems such current to be objectionable, or if the presence and/or electrical characteristics of the grounding conductor current is in violation of rules and regulations governing the electrical system, as set forth by the authority having jurisdiction to promulgate such rules.”



Subcommittee 2 – Grounding Methods

- “NOTE: Some amount of current will always be present on the grounding conductors of an operating AC electrical system.”



Subcommittee 2 – Grounding Methods

Justification:

"At present, misinterpretation and misapplication of the term “objectionable” in NESC 92D is creating unsafe system conditions at numerous locations. Electric utility customers with little or no understanding of the importance of grounding are being encouraged to cut grounds to eliminate current they consider “objectionable” (e.g., earth current). Unfounded earth current and “electrical pollution” concerns and the number of individuals misinterpreting and misapplying NESC 92D is on the increase. The number of system grounding conductors being cut by uninformed individuals because the term “objectionable” is not defined in NESC 92D is also on the increase."



Subcommittee 2 – Grounding Methods

094B7 – Revised to allow the use of steel poles as grounding electrodes under certain conditions:

- a. backfill around the pole is native earth, concrete, or conductive grout (not gravel),
- b. not less than (5.0 ft) of the embedded length is exposed directly to the earth, without nonconductive covering,
- c. the pole diameter is not less than (5 in),
- d. the metal thickness is not less than (1/4 in)



Subcommittee 2 – Grounding Methods

- Rule 096C – In response to an IR 532, Subcommittee 2 generated a proposal that adds a note to Rule 096C (otherwise known as the four grounds per mile rule).
 - “The intent is to ensure that grounds are distributed at approximately 400 meters (1/4 mile) or smaller intervals, although some intervals may exceed 400 meters (1/4 mile).”



Subcommittee 4 Overhead Lines – Clearances

Jim Bohlk



Subcommittee 5 Overhead Lines – Strengths and Loadings

Donald Heald



Members of Subcommittee 5 Overhead Lines - Strengths and Loadings Sections 24, 25, 26, and 27

- *EI (7 members)*
- *IEEE (5 members)*
- *AWPA*
- *AISI*
- *ATIS*
- *EIA*
- *NARUC*
- *NSPE*
- *SEEX*
- *BPA*
- *RUS*
- *TVA*
- *WAPA*
- *NRECA (2)*



Complete Rewrite of Sections 25, 26 & 27

- **PROPOSED –**
Rewrite eliminates L,M,and H Loading Districts and replaces these with construction, extreme wind, and extreme wind and ice loads.
- **Outcome for the preprint –**
 - *Accepted as an alternate method for the 2007 NESC*
- **FINAL VOTE–**
 - *Rejected*



New Combined Ice/Wind Map CP 2802

- **PROPOSED**

- *New combined ice and wind map; retain current requirements of Light, Medium, and Heavy Loading Zones.*

- *Outcome for preprint*

- *Accepted with modifications*

- **FINAL VOTE**

- *Accepted*



New Combined Ice/Wind Map

- *For Grade B, the radial thickness of ice from Figure 250-3 shall be multiplied by a factor of 1.00.*
- *For Grade C, the radial thickness of ice from Figure 250-3 shall be multiplied by a factor of 0.80.*
- *Structures and wires under 60 foot are excluded.*



Reference to ANSI O5.1-2002 CP 2780

- **PROPOSED**
 - Update reference of ANSI O5.1 in Rule 261A2b to ANSI O5.1-2002 .
- Outcome for preprint
 - Accepted
- **FINAL VOTE**
 - Accepted but SC 5 updated the reference to ANSI O5.1-2005 and added wording to the rule (Rule 261A2b(1))



Reference to ANSI O5.1-2002 CP 2780

- **FINAL VOTE**
 - Accepted but SC 5 updated the reference to ANSI O5.1-2005 and added to the rule the wording:

The “fiber stress height effect” of ANSI O5.1-2005 shall be considered for all naturally grown wood poles, greater than 55 feet in length, installed as single-based structures or unbraced multiple-pole structures.



Ground line moments CP 2781

- **PROPOSED** –
To remove Exception 1 to Rule 261A2a



Ground line moments

What does Exception 1 to Rule 261A2a say?

“When installed, naturally grown wood poles acting as single based structures or unbraced multiple pole structures, shall meet the requirements of Rule 261A2a without exceeding the permitted stress level at the ground line for unguyed poles or at the points of attachment for guyed poles.”



Ground line moments CP 2781

- **PROPOSED** –
To remove *Exception 1 to Rule 261A2a*
- Outcome for preprint–
– Accepted.
- **FINAL VOTE**–
– Accepted but revised the exception and added note 2. Also, acceptance is contingent on ANSI O5.1-2005 being approved.



Ground line moments CP 2781

- **FINAL VOTE**–
 - Revised Rule 261A2a by rewording the exception and adding note 2 as follows:
 - **NOTE 2: Maximum stress can occur above ground line.**
 - **EXCEPTION 1: When installed, naturally grown wood poles, not greater than 55 feet in length, installed as single-based structures or unbraced multiple-pole structures, need only meet the requirements of Rule 261A2a without exceeding the permitted stress level at the ground line for unguyed poles or at the points of attachment for guyed poles.**



*The 2007 edition of the NESC for
wood poles over 55 ft in length:*

- *Design is to be based on decreasing fiber stress with height*
- *Design is to be based on the maximum stress point above ground*



*The 2007 edition of the NESC for
wood poles over 55 ft in length:*

- *Design is to be based on decreasing fiber stress with height*
- *Design is to be based on the maximum stress point above ground*



60 foot exclusion (250C) CP's 2766, 2673, and 2798

- **PROPOSED** –
 - Remove 60 ft Exclusion Limit
- **Outcome for the preprint** –
 - Accepted 2766 with modifications. This CP removed the 60 ft exclusion but established a max. design wind load for structures under 60 ft.
- **FINAL VOTE** –
 - Rejected all CP's (60 ft. exclusion remains)



60 foot exclusion remains (Rule 261 A2a Exception 1)

- CP's 2766, 2763, and 2798 are rejected based on information obtained from public comments. Utility experience has demonstrated that electrical distribution and communication line structures, under 60 ft in height, are damaged during extreme wind events by trees, tree limbs, and other flying debris. Designing structures with heights less than 60 ft for extreme winds will increase pole strengths for distribution systems resulting in large increases in cost and design complexity without commensurate increases in safety. Safety of employees and the public is provided using the current NESC loading requirements.



Change Load Factor for Grade C Extreme Winds CP 2739

- **PROPOSED** - The load factor for extreme winds and Grade C construction is changed to .87
- Outcome for the preprint - Accepted in principal, see CP 2766.
- **FINAL VOTE** - Accepted as originally submitted



Remove Alternate Method CP 2717

- **PROPOSED** –
Remove the alternate method (Table 253-2 & 261B)
(the 'old method' ---ocf 4 and 2.67/2
for Grades B & C)
- Outcome for preprint –
Accepted
- **FINAL VOTE**
Accepted but modified the CP. The alternate method
shall not be used after July 31, 2010.



CP 2707 - Removal of 'k' factor from Table 251-1

- **Proposal** - Removal of the 'K' factor from Table 251-1 used to determine sags and tensions
- Outcome for preprint
 - Accepted as modified
- **Final Vote** -
 - Rejected modified CP



Other Changes

- Removal of the words *urban and rural* in section 24 (CP 2717)
- Changing the wording of overload factor to load factor throughout sections 25 and 26 (CP 2767)



Other Changes (continued)

- '3-pole rule' is eliminated (CP2553)
- Table 253-1 (load factors) is reformatted to the heading (CP 2552):

<u>Grade B</u>	<u>Grade C</u>
<u>All locations</u>	<u>At crossings Elsewhere</u>
- Load factors and strengths factors were added for fiber reinforced polymer structures (CP 2569)



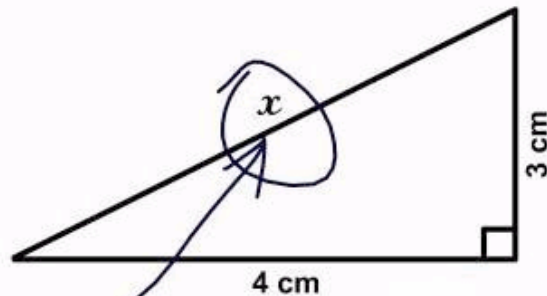
Other Changes (continued)

- The strength of climbing and working steps is spelled out in a new rule 261N (Capable of supporting 2.0 times 300 pounds, unless otherwise quantified by the owner). (Modified CP 2709)
- An appendix is added with examples demonstrating calculations for extreme wind. (CP 2784)



Why Math teachers go bald.....

3. Find x .



Here it is



Subcommittee 7 Underground Lines

Trung Hiu



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**2006 ELECTRIC ENGINEERING
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**NRECA's Transmission & Distribution
Engineering Committees**

**Michael Pehosh, Principal Engineer
National Rural Electric
Cooperative Association**

**Robert Saint, Principal Engineer
National Rural Electric
Cooperative Association**



NRECA T&D Engineering Committee

RUS Engineering Workshop

Orlando, FL

February 14, 2006

Bob Saint & Mike Pehosh



Who is the T&D Engineering Committee?

A voluntary and collaborative community of more than 80 experienced cooperative engineering professionals who work with the Rural Utility Service's (RUS) Electric Staff Division and other standards organizations to update technical bulletins, standards and guides for electric co-op systems.



Mission:

The Mission of NRECA's Transmission & Distribution Engineering Committee is to develop and promote the implementation of the most appropriate engineering practices and materials that support rural utility challenges.



Goals:

- Represent rural cooperative utility and community interests
- Assist RUS in the timely development and dissemination of standards, specifications, guide bulletins, and other technical information
- Provide modern, cost effective, safe, and environmentally conscious engineering solutions utilizing appropriate techniques



T&DEC Executive Committee

Chairman: Max Davis, South Alabama EC

RUS Liaison – Georg Shultz, Electric Staff Division

Six Subcommittee Chairs

NRECA Liaisons: Mike Pehosh
Bob Saint



T&DEC Subcommittees

Overhead Dist.: Tom Hoffman, Agralite Electric Co-op

Substation: Dan Geiger, Great River Energy

Syst. Planning: Joe Dorough, Jackson EMC

Power Quality: Ed Bevers, Rural Electric Cooperative

Transmission: John Burch, Florida Keys Electric Co-op

Underground: Steven Gwinn, Warren RECC



Power Quality Subcommittee

- CEATI Power Quality Interest Group
 - Solutions to Power Quality Disturbance Problems
 - Establishing Power Quality Guidelines
 - Defining Grades of Power Quality
 - Review and update of Power Quality Measurement Protocol
 - Impact Assessment of Distributed Wind Generation
 - Customer Power Factor Correction Capacitor Application Guide
- Annual Reliability Reporting Practices Survey
- Interruption Reporting and Service Continuity Standards for Electric Distribution Systems
- Voltage Levels of Rural Distribution Systems



System Planning Subcommittee

- IEEE DG Interconnection Standards/Guides
 - Testing
 - Application Guide
 - Information Exchange
 - Islanding Systems
- DG Interconnection Toolkit
- Long Range Planning Guide
- Sectionalizing Guide



Transmission Lines Subcommittee



- Design Manual for High Voltage Transmission Lines
- Transmission Specifications and Drawings
 - Wood
 - Concrete
 - Steel
- Transmission Lines Grounding Design Guide



Other Activities – Bob Saint



- Cooperative.com E&O Community
- NESC Committee and Subcommittees
- Power Systems Engineering Research Center (PSERC)
- NRECA International Division
- Software Integration Initiative (MultiSpeak®)



Overhead Distribution Line Sub.



- Operations manual development
- Voltage Regulator bulletin review
- Guying bulletin
- Streamline bulletin and guide approval process
- Monitoring NESC activity
- DALCM activities
- Review & update 1724E-153 Guy Bulletin



Underground Line Subcommittee



- BULLETIN 1728F-U1
- Looking at pad mount enclosures
- Semi-con jacketed cable
- Pad Mount Transformers
- Riser Pole arresters
- Stand off brackets
- Helping update the CRN 90-8 Underground Distribution Design and Installation Guide
- ICC activities
- DALCM



Substation Subcommittee



- 1724E 302 Spill Prevention Guide
- Transformer Witness Testing Guide
- 1724E 301 Guide for Evaluation of Large Power Transformers Losses
- Catalog for Alternative Substation Designs



Other Activities – Mike Pehosh



- CEATI DALCM
- Supply Chain Community
- NEETRAC
- Gridwise and Gridworks
- Wind Power America
- APLIC
- NESC
- IEEE Working Groups
- IEEE-ICC
- IEEE REPC



New Members for T&DEC

- Join T&DEC we need you and your expertise to help each other stay on top of the fast technology changes.
- More information and an application is on cooperative.com
- Or you can contact Bob Saint or Mike Pehosh at NRECA.
 - Robert.Saint@nreca.coop
 - Michael.Pehosh@nreca.coop

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

**Cooperative Experience on Compliance
with the ERP Regulation**

**Brad Hyland
Manager of Safety, Training,
Security and Facilities
Hoosier Energy Rural Electric
Cooperative**

BIOGRAPHICAL SKETCH

Brad Hyland

Brad Hyland has worked in the electric utility industry for 35 years. The past 28 of those years have been with Hoosier Energy REC in Bloomington Indiana.

He has been a part of the Hoosier Energy's Safety & Training Department for 8 years with the last 2 years serving as Manager of Safety, Training, Security and Facilities.

In addition to his duties at Hoosier Energy, Hyland serves as an alternate member of NERC'S Critical Infrastructure Protection Committee.

RUS Engineering Seminar 2006

Hoosier Energy REC VRA and ERP Development

Brad Hyland
Manager of Safety, Training, Security & Facilities
Hoosier Energy REC

Hoosier Energy Facilities





Hoosier Energy REC

Generation Assets

- Two coal fired generating stations with a combined capacity of 1270 MW
- Two gas fired combustion turbine generating stations with a combined capacity of 432 MW



Hoosier Energy REC

Power Delivery Assets

- 1400 miles of transmission lines from 69kV to 345kV
- 14 primary transmission substations
- 250 distribution substations along with numerous metering points



Common Industry Emergency Plans

- Emergency Action Plan
- Storm Response Plan
- Mutual Aid Agreement

- Emergency Restoration Plan (ERP)



Examples of Emergencies

- **South Central Indiana REMC**
Severe weather
- **City of Bloomington Utilities**
Fire
- **South Central Indiana REMC**
Power outage

RUS Bulletin 1730B-2

UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service
Bulletin 1730B-2

SUBJECT: Guide for Electric System Emergency Restoration Plan

TO: RUS Electric Secretaries and RUS Electric Staff


EFFECTIVE DATE: Date of Approval

OFFICE OF PRIMARY INTEREST: Electric Staff Division, Electric Programs

FILED INSTRUCTIONS: This is a new bulletin and file with 7 CFR Part 1730.

AVAILABILITY: This bulletin is available on the RUS electric website at:
<http://www.rusda.gov/electric/bulletins.htm>.

PURPOSE: This guide bulletin contains information to assist RUS electric secretaries in the development of a vulnerability and risk assessment (VRA) and an Emergency Restoration Plan (ERP). This guide bulletin provides references to existing resources and suggested practices with respect to security of critical electric infrastructure.


Robert E. Shultz
Assistant Administrator, Electric Programs

January 7, 2005
Date

RUS Implementation Schedule

- Vulnerability and Risk Assessment completed and certification to RUS on or before **July 12, 2005**
- Emergency Restoration Plan completed and certification to RUS on or before **January 12, 2006**
- Exercise of Emergency Restoration Plan completed on or before **January 12, 2007**



Resources for Emergency Planning

- **Emergency Management Guide for Business & Industry**
<http://www.fema.gov/library/bizindex.shtm>
- **RUS Bulletin 1730B-2**
<http://www.usda.gov/rus/electric/pubs/1730b-2.pdf>
- **Security Guidelines for the Electricity Sector: Version 1.0**
<http://www.nerc.com/~filez/cipfiles.html>



Resources for Emergency Planning

- **Disaster Recovery Journal**
<http://www.drj.com>
- **Disaster-Resource. COM**
<http://www.disaster-resource.com>

Emergency Management Guide for Business & Industry



September 11, 2001





Immediate Actions After 9-11

- Establishment of a Corporate Security Committee
- Senior Management supplied the committee with necessary resources to carry out their responsibilities



Corporate Security Committee

Member make-up

- Power Delivery
- Power Production
- Information Systems
- Corporate Communications
- Safety, Training & Facilities
- Co-chairs are Vice Presidents of these divisions



Corporate Security Committee

Actions Taken

- Identified available industry resources for information and assistance concerning security matters
- Contracted for vulnerability assessments
- Identified critical facilities
- Developed a quick hit list



Corporate Security Committee

Identify critical facilities

- The committee used procedures outlined in the NERC Security Guidelines for the Electricity Sector to determine Hoosier Energy's critical facilities



NERC Definition of Critical Assets

- “Those facilities, systems, and equipment which, if destroyed, damaged, degraded, or otherwise rendered unavailable, would have a significant impact on the ability to serve large quantities of customers for an extended period of time, would have a detrimental impact on the reliability or operability of the electric grid, or would cause significant risk to the public health and safety.”



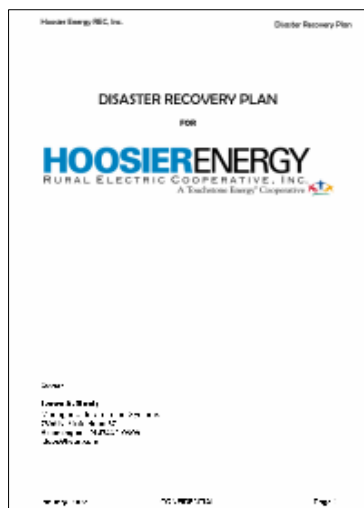
Response to Assessments

- The Security Committee considered information revealed during the vulnerability assessments and developed various plans to address these issues. An action item register was started noting assignments and deadlines

Security Committee Action Items

Corporate Security Committee (CSC)					
ACTION ITEM REGISTER					
= complete					
A/I #	Date Given	Task Description	Assigned To	Assigned/Actual Completion Date	Status (A)Active (I)Inactive (C)Complete
1	10/09/01	Prepare Draft Purpose Statement	Chris, Ian Paul R	10/31/01	C
2	10/09/01	Engage security consultant to do immediate assessment of plants	Fred, Ian, Jerry	10/31/01	C
3	10/09/01	Engage security consultant to do immediate assessment of Bloomington Facilities & Transmission	Paul B, Bob, Phil	10/31/01	C
4	10/09/01	Further assessment of facilities to follow immediate assessment. Merom focus on controlling access/egress	F. Southworth	1/21/2003	C
5	10/09/01	Establish back up control center at Worthington	Darrell, Dave, Paul B & Bob	12/31/01	C
6	10/09/01	Increase guard service at Merom & establish day guard service at Ratts	Fred, Ian, Jerry	10/22/01	C
7	10/09/01	Review & establish delivery policy for each location	TBD	PI, FS, IB	C
8	10/09/01	Employee ID Cards & Visitor Passes	Bob	11/16/01	C
9	10/09/01	Communication Memo to employees advising them of actions taken & procedures to be followed	Gale, Paul B, Paul R	10/12/01	C
10	10/09/01	Install Control Access Doors for Selected Bloomington Facilities, & Gate to Garage Area	Bob, Paul B, Darrell & Phil	11/30/2001	C
11	10/09/01	Plant Recommendations for implementing Control Access Door measures	Fred, Ian, Jerry	10/19/01	C
12	10/09/01	HQ Main Entrance - install monitor & control at reception desk	Paul B & Phil	ASAP	C
13	10/09/01	Investigate availability of outside resources e.g. NERC, NRECA, DOE, NRC, EPRI, etc.	Paul B & Chris	TBD	C
14	10/09/01	Monitor and make recommendations on how to influence and/or respond to public policy initiatives	Randy Haymaker	TBD	Ongoing
15	10/09/01	Review & Establish IS protection & recovery plan	Paul B & Lance Davis	TBD	C
16	10/09/01	Investigate need for providing air travel guidelines to employees	Paul B & Chris	TBD	C
17	10/09/01	Identify Local FBI Contact Persons	Bob, Fred	ASAP	C
18	10/9/01	Explore feasibility of working with Williams to establish security measures and establishment of back up control capability at Worthington Primary	Dave, Bob Hill	TBD	C
19	10/9/01	Establish cost tracking mechanism and prepare cost estimates for implementing recommendations	Paul R, Aron Tamm	ASAP	C
20	10/31/01	Develop training resources for HE work force	Paul B & Bob R	ASAP	C
21	10/31/01	Determine CRN/NRECA interest in work force training	Paul R	11/16/01	C
22	10/31/01	Evaluate & recommend implementation of COG recommendations for HE facilities	Plant: FS, IB & JS, Burrett & Other: DK, PJ & DG	11/16/01	C
23	10/31/01	Prepare Administrative Bulletin for employee ID badge procedures	Bob R & Roger Owens	11/16/01	C

IS Disaster Recovery Plan



Importance of IS Recovery Plan

- Identified Critical Business Activities by conducting a Business Impact Analysis
- Established methodology to restore the business network and critical applications
- Completed in 2002
- Used as a model for ERP

RUS Bulletin 1730B-2

UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service
Bulletin 1730B-2

SUBJECT: Guide for Electric System Emergency Restoration Plan

TO: RUS Electric Borrowers and RUS Electric Staff


EFFECTIVE DATE: Date of Approval

OFFICE OF PRIMARY INTEREST: Electric Staff Division, Electric Programs

FILE INSTRUCTIONS: This is a new bulletin and file with 7 CFR Part 1730.

AVAILABILITY: This bulletin is available on the RUS electric website at:
<http://www.rusda.gov/electric/bulletins.htm>.

PURPOSE: This guide bulletin contains information to assist RUS electric borrowers in the development of a vulnerability analysis assessment (VAA) and an Emergency Restoration Plan (ERP). This guide bulletin provides references to existing resources and suggested practices with respect to security of critical electric infrastructure.

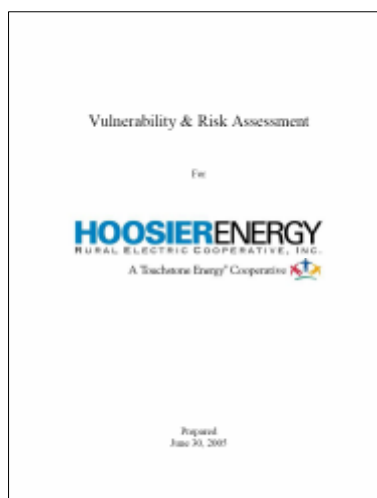

Julian E. Neeley
Assistant Administrator, Electric Programs

January 7, 2005
Date

Developing an Emergency Restoration Plan

- Establish a planning team
- Perform Vulnerability/Risk Analysis
- Develop the plan
- Review and modify plan
- Seek plan approval
- Implement the plan
- Exercise plan

Vulnerability & Risk Assessment





Vulnerability & Risk Assessment

- Critical facilities & assets
- Business operational assets
- Exposure & possible mitigation methodology



RUS Definition of Critical Assets

“ Those facilities or business functions that if damaged or destroyed would cause significant loss of life, risk to public health, negatively impact the ability to serve a large portion of its customers for an extended period of time, have a detrimental impact on the reliability or operability of the energy grid, or impact continuity of business to the point where the repayment of RUS loan funds are jeopardized.”

Vulnerability & Risk Assessment

- Develop Vulnerability Analysis Chart
- Estimate Probability
- Assess the Potential Human Impact
- Assess the Potential Property Impact
- Do the Math

Vulnerability Analysis Chart

Vulnerability Category	Vulnerability Sub-Category	Estimated Probability				Estimated Human Impact	Estimated Property Impact
		Low	Medium	High	Very High		
Structural	Foundation	1	2	3	4	5	6
Structural	Walls	1	2	3	4	5	6
Structural	Floors	1	2	3	4	5	6
Structural	Roofs	1	2	3	4	5	6
Structural	Windows	1	2	3	4	5	6
Structural	Doors	1	2	3	4	5	6
Structural	Stairs	1	2	3	4	5	6
Structural	Elevators	1	2	3	4	5	6
Structural	Other	1	2	3	4	5	6
Non-Structural	Interior Finishes	1	2	3	4	5	6
Non-Structural	Exterior Finishes	1	2	3	4	5	6
Non-Structural	Landscaping	1	2	3	4	5	6
Non-Structural	Other	1	2	3	4	5	6

Vulnerability Category	Estimated Probability	Estimated Human Impact	Estimated Property Impact
Structural	1	5	6
Non-Structural	1	5	6

Vulnerability Category	Estimated Probability	Estimated Human Impact	Estimated Property Impact
Structural	1	5	6
Non-Structural	1	5	6

Vulnerability Analysis Chart
Location: Worthington Primary

(The lower the total the better)

Type of Emergency	Probability High 5 + + 1 Low	Impacts			Resources		Total
		High Impact Human	5 + + 1 Low Prosperity	Impact Business	Weak 5 + + 1 Strong Internal	External	
Robbery	3	1	1	1	4	2	12
Earthquake	1	1	3	3	4	4	16
Technical Staff	3	1	3	3	3	5	18
Fire - Wreck	3	1	3	3	3	5	17
Gas System	3	1	2	3	3	5	17
Tornado	3	1	3	3	4	5	19
Power Outage - major	1	1	3	3	5	4	21
Fire - Major	4	1	4	3	3	3	18
Fire - Minor	3	1	2	3	3	2	15
Telecom - Feature Data	3	1	1	3	2	2	11
Telecom - Feature Voice	3	1	1	1	2	2	9
IT/24/7 - Technical	1	1	1	3	4	2	11
Chem Threat	1	1	1	1	2	2	8
Vandalism	2	1	2	2	2	3	12
Lockdown	1	1	3	4	3	1	13

Emergency Restoration Plan

Hosier Energy LLC Inc. Emergency Restoration Plan

Emergency Restoration Plan
FOR

HOOSIERENERGY
 RURAL ELECTRIC COOPERATIVE, INC.
 A Buckeye Energy Corporation

Cooperatives
 11000 Highway 10
 P.O. Box 10000 Columbus, Ohio 43261-1000
 (614) 444-1000
 Fax: (614) 444-1001

Plan No. 1000 10/10/2015



Goals of ERP

Establish recovery sites within 1 to 24 hours

- Use Hot Sites
- Reciprocal use agreements
- Purchase equipment and supplies locally
- Preplanning
- Dedicated resources are made available
- Pre-installed basic infrastructure



Goals of ERP

Establish interim sites within 7 days

- Purchase equipment and supplies locally
- Multiple interim sites are available
- Dedicated resources are made available
- Pre-installed basic infrastructure



Emergency Restoration Plan (ERP)

RUS Required Elements

- List of key contact emergency telephone numbers.
- List of key utility management and other personnel
- Procedure for the recovery from loss of electricity to the headquarters



Emergency Restoration Plan (ERP)

RUS Required Elements

- A business continuity section describing a plan to maintain or re-establish business operations
- Other items identified as essential for inclusion in the ERP

[illegible]

Restoration Team Members

Emergency Restoration Team Organization Chart

```
graph TD; CEO[President and Chief Executive Officer] --> VPMS[Vice President Management Services Team Leader]; VPMS --> VPP[Vice President Power Production]; VPMS --> SVP[CFO Senior Vice President and CFO]; VPMS --> VPS[Vice President Power Supply]; VPMS --> VFC[Vice President Finance and Controller]; VPMS --> SVPBD[Senior Vice President Marketing and Business Development];
```

ERP Table of Contents

Hawai'i Energy REC, Inc.	Emergency Restoration Plan
Table of Contents	
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What's Next?

- Train the balance of employees on the plan
- Complete the infrastructure for the plan
- Design the plan exercise
- Be prepared to modify the plan
- Maintain the plan current



RUS Contact Information

- **John B. Pavek**

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Stop 1569 Independence Avenue, SW
Washington, DC 20250-1569

Phone: 202-720-5082
email: john.pavek@usda.gov



Questions?

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

New Concepts in Long Range Planning

**Jim Bohlk
Electrical Engineer
Distribution Branch**

BIOGRAPHICAL SKETCH

Jim Bohlk

In his 15 years at RUS, Jim has been the lead engineer in updating the overhead distribution construction standards and several new distribution guide bulletins. Before coming to RUS, Jim was a distribution engineer at an investor owned electric utility and a system engineer at an electric cooperative in Michigan.

Long-Range System Planning

Bulletin 1724D-101

Jim Bohlk

***Electric Staff Division
Distribution Branch***

RUS Bulletin 1724D-101

“Electric Distribution System Long-Range Planning Guide”

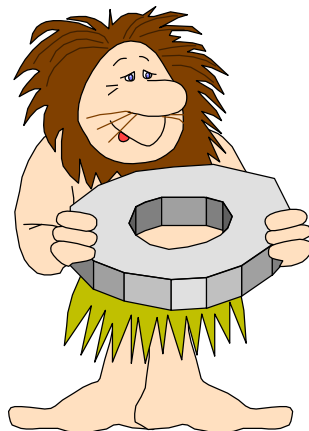
- ***Recently updated
with new guidelines***
- ***Organized like
standard, engineering
problem-solving procedure***
- ***New guidelines
promote methods
to minimize future costs***



Problem Solving & Planning

- 1. Gather & Analyze Data & Information***
- 2. Define the Problem***
- 3. Determine All Feasible Solutions***
- 4. Analyze & Compare Each Solution***
- 5. Determine & Recommend Best Solution***
- 6. Justify & Document Recommendations***

The Missing (Cost-Saving) Link



4.5

***Apply
Engineering
Economics
Using the
Time - Value
of Money***

New General Guidelines

- *A new LRP may be postponed*
- *Use a “One System” approach*
- *Loads need to be consistent with system’s Load Forecasting Study*
- *Planning period long enough to stress the system*
- *Intermediate plans are optional*

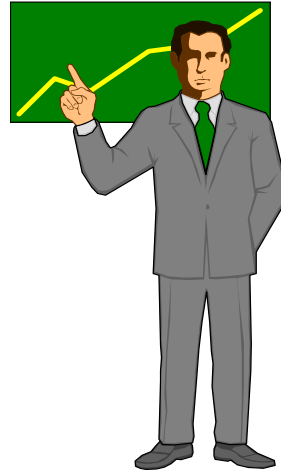
Planning By Areas; A New Viable Option

(“Areas” are regions with similar load growths and characteristics.)

- *Disadvantages of traditionally LRP*
- *Fast-growing areas: More timely planning*
- *Slow-growing areas: Postpones new LRP*
- *Each “area plan” may have different planning period*
- *“Area” planning makes conversions to higher voltages more attractive*

Design Criteria

- ***Defines the standards for the system***
- ***Developed by Engineer***
- ***Needs agreement before study begins***
- ***Address all aspects of the system***
- ***Needs documentation and explanation***



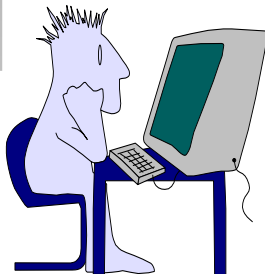
Gather Information and ...

Analyze Historical Data

(Only compile data used in and for study)

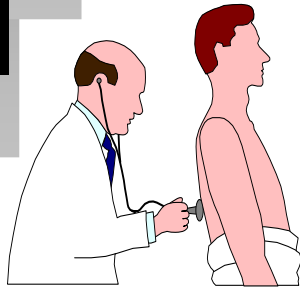
Analyze Studies, Plans & Programs

(Write concise summary reports regarding impact)



Update Maps & Computer Model

Problem Identification



☒ **ANALYZE:**

*Distribution Circuits & Equipment
Transmission Lines & Substations
Power Supply*

☒ **LISTS PROJECTED PROBLEMS**

*Primary Voltages
Conductor, Equipment Loading
Reliability, Etc.*

☒ **ENTER DATA ON SYSTEM MAPS**

Problem Solutions

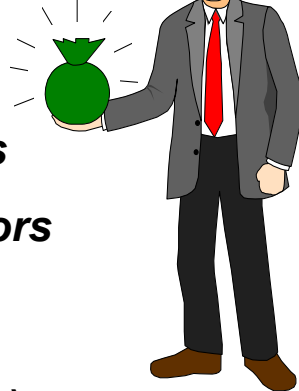


- **Usually more than 1 solution**
- **Use “Guess & Test” method**
(Feasible? Practical? Solve Problem?)
- **Estimate cost & apply engineering economics****
- **Compare costs & benefits**
- **Deteriorated lines? Keep solutions simple**





***Bulletin 1724D-104 “Engineering Economics
Computer Workbook Procedure”*

Least Costly Solutions

- ⇒ ***Transfer Loads***
- ⇒ ***Balance loads between phases***
- ⇒ ***Replace regulators***
- ⇒ ***Install line regulators and capacitors***
- ⇒ ***Build tie line (and transfer loads)***



Document Recommendations

-  ***Lists***
-  ***Tables***
-  ***Narratives***
-  ***System Map (with changes)***



Write LRP Report



- **RUS “acceptable” format and details in bulletin**
- **Keep document short and to the point**
- **Map conditions of system before and recommendations**
- **Explain and “justify” recommendations**

Presentation and Approval



Present to Manager, GFR, Power Supplier & Board

Answer Questions and Modify as Needed

Needs Approval by Board Resolution

Scrutinize Study and Report

Look for:

- *Alternative Solutions*
- *Economic Analysis*
- *Good Descriptions*
- *Justification of Items*
- ***Ways to Save Money !***



**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

Load Forecasting

**Sharon Ashurst
Senior Load Forecast Officer
Energy Forecasting Branch**

BIOGRAPHICAL SKETCH

Sharon Ashurst

Sharon Ashurst is a Senior Load Forecast Officer with the Energy Forecasting Branch where she reviews load forecasts of some of RUS' largest borrowers. Currently, she reviews biomass projects, represents RUS on biomass matters at the Department level.

Sharon began her career at Potomac Electric Power Company in Washington, D. C., where she performed load research on the class and end-use levels and appliance saturation studies. Just prior to joining RUS she worked for Niagara Mohawk Power Corporation in Syracuse, New York, where she assisted in the installation and development of a data base and load analysis package and trained load research analysts. She also performed cost of service studies for both gas and electric sectors of the company, and designed transportation rates on the gas side, industrial real time rates, and residential time of use rates for electric customers. She has testified before the New York State Public Service Commission on gas and electric issues and has written several reports for national publication.

She earned a Masters in Business Administration, and her thesis examined competitive strategies for rural utilities in a deregulated environment.



Load Forecasting An Overview

**Sharon Ashurst
Energy Forecasting
Rural Utilities Service**

Agenda

- **Introduction**
- **Topics –**
 - **Loan Feasibility**
 - **Load Forecasting – background**
 - **Load Forecasting Regulations**
 - **Criteria for a Forecast**
 - **Appliance and Customer Surveys**
 - **RUS Analysis**

Criteria for Loan Feasibility -- Projections

- **Provide reasonable assurance of loan repayment**
- **Meeting TIER and DSC**
 - Power requirements
 - Rates
 - Revenues

Reasonable Competition with Other Utilities

- **Can consumers be reasonably expected to pay proposed rates required to cover expenses to meet TIER and DSC**
- **Prevention of substantial load loss – how will this affect loan feasibility**
- **Will the borrower be able to provide satisfactory service to consumers**

Loss of Loads – Large Commercial or through Annexation

- **Will loss of large consumer load or large concentration of load substantially affect loan feasibility**
- **What are the risks of losing load to annexation or other causes**
- **Risk analysis may be required**
 - Government planning boards
 - Annexation plans of municipalities
 - Other relevant information

State Regulatory Authorities

- **Reasonable expectation of State's approval of rates or investment**
- **Decisions to enable loan repayment**

Experience and Performance of System's Management

- **Sufficient management control or contractual safeguards in construction and operation of jointly-owned facilities to ensure borrower's interests are protected**

Load Forecasting Background

- **Methods used**
 - **Evolution**
 - **Importance**
 - **Costs**

Definition of Load Forecast

- **Thorough study of a borrower's electric loads and factors affecting those loads in order to determine the borrower's future requirements for energy and capacity**
- **The load forecast of a power supply borrower (PSB) includes and integrates the forecasts of its members**

Load Forecast

- **One of the primary documents required to support a loan application**
- **RUS may require new or updated forecast for approval to determine loan feasibility or to ensure compliance under loan documents**

Power Supply Borrowers Who Files?

- **Large Power Supply Borrowers (total utility plant >\$500 million)**
 - Prepare for approval a new forecast every three years with annual updates or
 - Prepare for approval of new forecast every two years, with new models and equations.
 - Maintain current forecast work plan approved by RUS
 - Provide current RUS-approved forecast in support of request for RUS financial assistance or RUS approval of long term power contracts.

Power Supply Borrowers Who Files?

- **Power Supply Borrower, member of large PSB**
 - Must meet requirements of large PSB -- only large PSB is required to file work plan.
 - RUS may extend time frame up to three months for large PSB if,
 - RUS determines borrower is in compliance with approved work plan, and
 - Significant changes in existing forecast models and assumptions are not required
 - Determination of whether forecast is current is made at the time of financial assistance is request.

Power Supply Borrowers Who Files ?

- **Small Power Supply Borrowers (total utility plant <\$500 million)**
 - Not required to maintain an on-going forecast
 - Must file in support of:
 - Application for RUS loan or loan guarantee if loan guarantee exceeds \$50 million, or
 - Request for RUS approval of long-term power contracts or other actions, on a case by case basis.

Distribution Borrowers Who Files?

- **Distribution borrower (member of large PSB) must maintain approved forecast**
 - Work plan is responsibility of PSB
- **All other, including unaffiliated distribution borrowers and members of small PSB must:**
 - Meet requirements of small PSB for loans of \$3 million or 5% of total utility plant.
 - Meet requirements of large PSB if distribution borrower owns generation and transmission >\$500 million

Basic Policies and Requirements for a Load Forecast

- **Load forecast / updates completed and submitted on a timely basis**
- **Load forecast completed within 12 months of work plan submission**
- **Coordination between PSB and members, open communication between RUS, borrower's staff and consultants**
- **All documentation, data and other relevant information in RUS acceptable formats that support the current work plan**
- **Borrower may be required to submit new or updated forecast to ensure loan security**

Basic Policies and Requirements for a Load Forecast

Load forecast must contain the following:

- **Scope: system planning, load management, energy efficiency programs, plant investments, and financial planning**
- **Personnel, consultants, data and other resources used**
- **Procedures to collect, develop, verify, validate, process and update data**
- **Analysis, modeling, relevant data, sensitivity analyses, and substantive procedures to test assumptions**

Continued

– **Correlation and Consistency**

- **Approved forecast and other support documents were reconciled**
- **Load forecast – wholesale power costs, distribution costs, system costs, average revenue per kWh, and inflation**
- **Engineering planning documents i.e., the construction work plan**

Continued

- **Analysis of borrower's electric system loads;
land patterns;
Potential losses of load due to annexation or other causes;
Residential and commercial development;
Rate levels and rate competition;
Appliance saturations and usage patterns;
Alternative energy sources
Load management, conservation, and power marketing**

Continued

- **Alternative scenarios desired**
 - **Most probable economic assumptions with normal weather (Base case)**
 - **Most probable economics with severe weather**
 - **Most probable economics with mild weather**
 - **Normal weather with pessimistic economic assumptions**
 - **Normal weather with optimistic economic assumptions**
 - **Impacts of wholesale or retail competition**
 - **New environmental requirements**

Continued

- **10 years data from RUS Form 7 Part R**
- **Database tracking all relevant variables influencing loads**
- **Documentation of coordination between PSB, its members and RUS**
- **Recommendation of borrower's general manager to the board of directors**
- **Approval by the board of directors**

Continued

- **Load forecast and supporting data and analysis shall be retained by borrower until next new forecast is approved by RUS**
- **Work plan is retained**
- **RUS retains load forecast for 10 years**

Basic Criteria for RUS Approval of Load Forecast

- **Adequate documentation and assistance to allow for a thorough and independent review**
- **For a PSB:**
 - **Adequate coordination with members in preparation of work plan and forecast**
- **Letter of recommendation by the borrower's general manager for approval and approval by the borrower's board of directors**

Continued

- **Borrower**
 - objectively analyzed all factors influencing consumption of electricity and requirements for generation and transmission capacity.
 - objectively analyzed power requirements for RE Act and non-Act beneficiaries
 - developed adequate supporting data,
 - used valid assumptions,
 - analyzed a reasonable range of relevant alternative assumptions and scenarios,
 - adapted methods and procedures in general use by electric industry, and
 - used valid, verifiable analytical techniques and models

Work Plan Requirements

- **PSB is required to prepare a load forecast work plan**
 - The work plan shall establish: resources, methods, schedules and milestones used in preparation and maintenance of the forecast
- **PSB's work plan includes member inputs and coordination mechanisms for preparation of each member's forecast**
 - Members concurrences required
 - PSB and members must follow work plan
- **Work plan must be approved by Board of Directors**

Continued

- **Work plan shall:**
 - Identify project leaders, liaisons, or consultants
 - Require residential consumer surveys at least every 5 years – appliance saturation and electricity demand (PSB with residential sales >50% of total sales)
 - Provide for all data collection and verification, analyses, modeling and documentation
 - Provide for on-going review by RUS of forecast
 - Cover a period of one to three years
- **Borrower may amend work plan with RUS approval**
 - New or revised work plan may be required if RUS concludes that existing plan will not result in a satisfactory or times forecast

Waiver of Borrower Requirements

- **RUS Administrator may waive any requirements applicable to borrowers, if waiving the requirement:**
 - Will not significantly impact the objectives of the rule, and
 - Requirements represent a substantial burden
- **Waiver must be requested in writing by the borrower's general manager**



Criteria for the Load Forecast

1. SCOPE

- **Period of study**
- **Historical analysis**
- **Projections of kWh sales, load shapes, peak demand by class, end use and system**
- **Uses of information developed in study**
 - Load management and conservation
 - Energy efficiency programs
 - Plant investment / CWP design
 - Financial requirements
 - Long range plan
 - Rates and rate design

2. Personnel and Data Sources

- **Personnel and consultants**
- **Data sources (historical and future)**
 - Weather
 - Demographics
 - Economics
- **System**
 - Operating reports
 - Surveys
 - Load research
 - Proxies
- **Data Processing**

3. Collect, Validate, Process and Update Data

- **Validation of Data**
 - System
 - Non-System
- **End-use surveys or total load surveys**
- **Update data annually**
- **Reclassification**
- **Mergers**

4. Analysis and Modeling

- **Customer classes and end-uses:**
 - Descriptions of each
 - Historical change
 - Numbers of consumers by class
 - Changes in classification or billing
- **Methodology and models**
- **Range of assumptions used in development of forecast**
- **Description of classes / compare growth**
- **Individual analysis of large commercial/industrial customers**
- **System losses**
- **Load factors**
- **Availability / quality of projections for variables**

5. Analysis of Borrower

- **Description of service territory**
 - Territorial agreements
 - Population served in area
- **Geography of area**
 - Topography and climate
- **Infrastructure – transportation and utility systems**
- **Population characteristics influencing the use of power and potential growth or changes**
- **Power purchases and /or generation capacity**

Continued

- **Sales and peaks**
- **Load management and conservation**
- **Economic conditions**
 - Major industries and sources of income
 - Alternative fuels and prices
 - Weather extremes
 - Population movement

6. Scenarios

- **Assumptions for the future**
- **Scenarios**
 - Most probable economics & normal weather
 - Most probable economics & severe weather
 - Most probable economics & mild weather
 - Normal weather & pessimistic economics
 - Normal weather & optimistic economics
 - Impacts of wholesale and retail competition
 - Changes in environmental laws

7. RUS Forms, Tables and Graphs

- **Form 7 Data**
- **Graphs, tables and spreadsheets**
 - Forecast results
 - Data Dictionary
 - Model specifications and statistics
- **Form 341 – Summary – no longer required**

8. Coordination between Borrower and RUS

- **Evidenced in Work plan and Load Forecast**

9. Approvals

- **Recommendation letter from General Manager to Board of Directors**
- **Approved, original resolution from Board of Directors**
- **Transmittal Letter to RUS signed by General Manager**
- **RUS approval (GFR for unaffiliated borrower)**

Goals for Power Supply Borrowers and their Members

- **To develop expert consensus with members on load projections and supply and demand options**
- **To anticipate and meet informational needs of policy and decision makers**
- **To meet the requirements of the public, regulatory and financial sectors**

Objectives

- **Maintain / improve coordination with member systems**
- **Develop / maintain valid and comprehensive data bases from existing data sources**
- **Maintain / improve annual sales forecasts**
- **Develop end use data through surveys and other sources**
- **Identify / develop data needed for modeling load shape and peak demand**
- **Identify / develop other resources needed for modeling load shape and peak demand**
- **Improve internal staff expertise and communication with departments**
- **Improve communication with RUS**

Afterword

- **Load forecast must be bound and not in loose leaf binder to facilitate filing**
- **Two copies to RUS Washington**
- **One copy to GFR**
- **Borrower should maintain copy of current until next forecast is approved**
- **Copy to remain on file at RUS for 10 years**

Appliance and Customer Surveys

- **Requirement for surveys**
 - **Uses and Importance**
 - **Coop vs Consultant**
 - **Examples**

RUS Analysis

- **Work Plan and Board Resolution**
 - Is it reasonable?
 - Will it provide reasonable results in an acceptable time frame?
 - Are resources appropriate?
- **What do we look for and how do we assess the validity of the forecast?**



Questions??

Thanks!

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

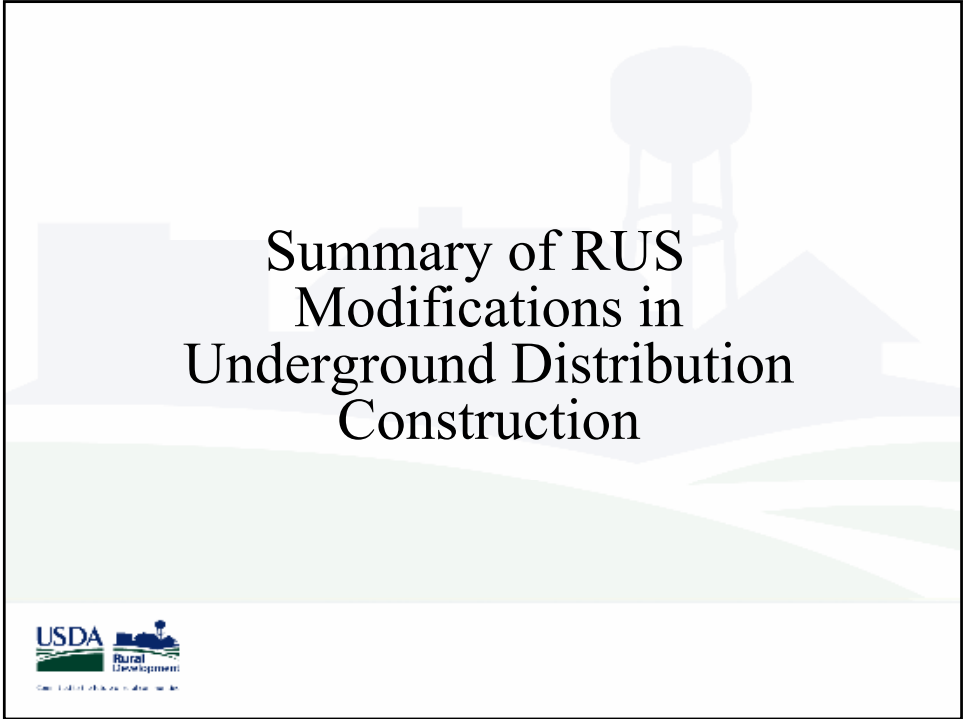
Underground Distribution Update

**Trung Hiu
Electrical Engineer
Distribution Branch**

BIOGRAPHICAL SKETCH

Trung Hiu

Mr. Trung Hiu is an electrical engineer and serves as the Underground Distribution Engineer in the Electric Staff Division at RUS. Mr. Hiu graduated from Virginia Tech in 1992. He has been with RUS for over ten years. His primary responsibilities include revising and updating the RUS Bulletin D-806, "Specifications and Drawings for Underground Electric Distribution" and the U-1, "Specification for 15 kV and 25 kV Primary Underground Power Cable." His area of specialty is URD Cables. He represents RUS at the ICC (Insulated Conductors Committee) Meetings, the ANSI Z535 Committee for safety signs, and the Subcommittee 7, Underground Lines, of the NESC (National Electrical Safety Code.)



Summary of RUS Modifications in Underground Distribution Construction



RUS Bulletin 1728F-U1 Revision Highlights

- Water blocking sealant
- XLPE will be removed
- TR-XLPE will replace XLPE.



RUS Bulletin 1728F-U1 Revision Highlights

- 25 kV cable insulation reduced from 345 mils to 260 mils
- 35 kV rated cable included
- Semi-conducting jacket cable.



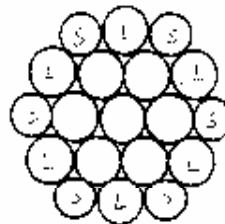
Acceptable Alternative Construction for 600 Volt Underground Cable

- 8000 series aluminum
- Abuse resistant insulation



Acceptable Alternative Construction for 600 Volt Underground Cable

- Stranding
 - ASTM B786 for aluminum 1350
 - ASTM B787 for copper conductors



19 Wire Combination
Unilay Stranded Conductor

ASTM B786 and B787



Acceptable Alternative Construction for 600 Volt Underground Cable

- Self-healing



Acceptable Alternative Construction for 600 Volt Underground Cable

- Compressed Round Aluminum Conductors
– ASTM B901



Safety Signs

- ANSI Z535
- “Caution” is obsolete
- “Warning” replaces “Caution”
- “Danger” is valid



Contact

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**2006 ELECTRIC ENGINEERING
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FEBRUARY 14-15, 2006

ORLANDO, FL

Underground Transmission

**Howard Barnes
General Field Representative
Colorado, Nebraska, Western Kansas
Southern Regional Division**

BIOGRAPHICAL SKETCH

Howard Barnes

Born in Washington, D.C., raised in Maryland and Virginia, graduating in 1972 from the University of Maryland with a B.S.E.E.

Howard has worked with the Rural Electrification Administration (REA) which was renamed the Rural Utilities Service (RUS) since 1972 initially in Washington, D.C. in the Southeast and Southwest regional engineering offices and later in the Financial Services Staff before traveling to Loveland, Colorado in 1987. Serve as the General Field Representative (GFR) in Colorado, as well as western Kansas and western Nebraska, with responsibilities covering a wide range of activities including assistance and oversight for RUS borrowers in these states. These activities include engineering and financial planning, loan application development, construction and maintenance activities, and management/board participation.

Howard has been actively involved in developing financial and engineering tools and software used by RUS systems throughout the United States including the RUS Financial Forecast, a 10 year projection of the system's overall financial condition, along with a more than 30 year graphical comparison of its historical performance.

“Underground Transmission” Practical Information and Issues for Consideration by Rural Electric Systems



Howard Barnes

USDA – Rural Development
General Field Representative

Electric Engineering Seminar
Orlando, FL February 15, 2006



Underground Transmission Issues

Will cover the following topics:

- What are the relevant factors to consider?
- What types of underground cable are available?
- What are their relative costs compared with overhead?
- Installation methods and accessories?
- Possible methodologies being used for cost recovery?
- What your electric cooperative might consider doing?

Rationales for Consideration

- Increased local pressure to place all utilities underground, if possible.
- Limited right-of-way available for specific overhead lines.
- Densely populated areas.
- Address localized constraints, i.e. airport, river crossing, etc.
- Conservation easements that preclude overhead utilities.
- Scenic attributes that are desired to be mandated by a community.
- Requirement by some states to evaluate underground alternative.
- NIMBY concerns.
- Extent of need for new transmission lines, which face public opposition.

Critical Need for Transmission

- Attention to the future needs of the U.S. transmission grid have been insufficient
 - No major new transmission investments in the last 15 years
 - Majority of transmission lines are over 20 years old
 - Average transmission project payback is 28.5 year

- Source: Edison Electric Institute

Underground vs. Overhead Factors

Overhead

- More visible
- 70 to 150 ft. ROW
- Less costly
- Subject to Weather (ice, wind, tornado)
- Span environmentally sensitive areas
- Lower repair costs which can be completed more quickly
- Any length of line

Underground

- Less visible which affects level of acceptance
- 20 to 75 ft. ROW; easement cost considerations
- Capital costs can be 3 to 10 times higher, or more, depending upon a host of factors
- Less susceptible but can be impacted by dig-ins
- Requires excavation or alternative routing
- Higher repair costs (when necessary) along with longer outages required for repairs
- Generally short sections to address specific, localized constraint

Routing and Siting Issues

- On the one hand, it may be possible to route an underground transmission line in areas that an overhead line might not be permitted including highly urbanized areas, near airports and water crossings, and potentially along a shorter route than might be available for a more indirectly routed overhead line.
- On the other hand...

Underground Constraints

- An underground transmission line, however, has its own set of constraints, that must be addressed, which definitely limits its application.
- These include significantly higher costs and who will bear this responsibility, the need for a highly engineered system that is much different than designing underground distribution facilities, greater construction impacts, restrictions on what can be sited above the underground line, and costly repair issues.

Distinctions between Underground Distribution and Transmission

- For those who are familiar with applying underground distribution, the transition to underground transmission involves **MANY** special engineering aspects including:
 - Cable ampacity is limited by the deepest point of its alignment or when placed within a steel casing, due to heating considerations. It is critical to calculate this current limiting aspect to avoid overloading.
 - Use of special low thermal resistant backfill assists in reducing heating through better dissipation in the surrounding soils.
 - It may be necessary to utilize a larger conductor size for sections that are enclosed in steel casing or require placement at greater depths.
 - Summer soil ambient temperature conditions for the particular location.
 - Configuration of the cables within the duct bank or steel casing.

Use of Copper or Aluminum Conductor



The overall cost of the cable system will be impacted by commodity prices at the time of purchase.

Bidding is needed to determine whether to utilize copper or aluminum conductor, due to their fluctuating metal market costs.

A copper conductor will be smaller in diameter than an equivalent aluminum conductor which then influences the extent and cost of insulation required (a greater amount of insulation is required for aluminum due to its larger overall size, with insulation costs affected by other commodity prices).

Need for Engineering Expertise

- One should think of an underground project as an overall “system” which must factor in not just the type/spec of cable to be installed, whether it is to be direct buried or installed in a duct, local soil conditions, potential changes in depth of installation, the need for road crossings and how this will be handled.
- It is critical that this underground “system” be designed by those with adequate engineering expertise.

Repairs When They are Needed



- When damage occurs to underground facilities, both the costs of the repairs as well as the time to do so are MUCH greater than with overhead transmission.

It is critical that spare reels of cable be available to the system. If installed in duct, the time to replace can be reduced, but at higher installed cost than if direct buried.

Most underground repairs involve multiple days including weeks, depending upon availability of skilled crews, compared with hours or a few days with overhead transmission in most cases.

Extent of Underground Transmission in the United States

- The initial underground transmission lines in the United States were surprisingly installed in the 1920's.

At this time, there are approximately 5,000 miles of underground transmission cable compared with 200,000 miles of overhead or 2.5% of overall mileage.



Types of Underground Systems

- High-Pressure Fluid-Filled (HPFF) pipe
- High-Pressure Gas Filled (HPGF) pipe
- Self Contained Fluid Filled (SCFF)
- Extruded Dielectric Cable (XLPE or EPR)
(most typical type currently being used for voltages below 230 kV)

High Pressure Fluid or Gas Filled (HPFF, HPGF)

All three conductors are installed inside steel pipe

Insulated with either oil or nitrogen gas

In the past, this was the most typical cable type used, which continues to be the case for higher transmission voltages, along with a proven track record of performance.

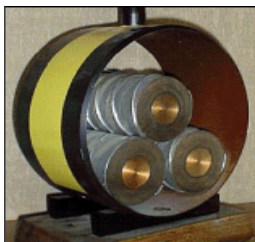


Photo courtesy PDC

Oil systems are more competitive when use for longer project lengths due to cost of the oil pressure system itself (approx. \$250,000).

High Pressure Fluid or Gas Filled (HPFF, HPGF)

- Use of saturated or filled (impregnated) paper tapes for insulating qualities is typical.
- Pressures are typically 200 psi nominal, but do increase.
- Gas systems utilize nitrogen, which is naturally occurring in the atmosphere, and therefore has different environmental impacts should a leak occur than with a pressurized oil system.
- Many of these lines installed as early as in the 1930's are still in operation today.
- These systems compose ~80% of total mileage installed.

High Pressure Fluid or Gas Filled (HPFF, HPGF)

- The designs of these two types are similar except:
 - Required insulation thickness for “gas” needs to be greater than with “fluid” systems, due to the lower electrical strength of gas compared with “fluid”.
 - At 115 kV, paper insulation thickness would be .485 inches for gas and .375 inches for fluid.
 - A “gas” system could be converted to an “fluid” system, at potentially a “higher” voltage, under certain cases.

Self Contained Fluid Filled (SCFF)

Most typically used for underwater installations; insulated with oil

Able to be installed to depths of 2,600 ft w/o special provisions

Each of three fluid filled cables are installed in individual pipes



Photo courtesy USI Power

Photo courtesy Prysmian Cables & Systems

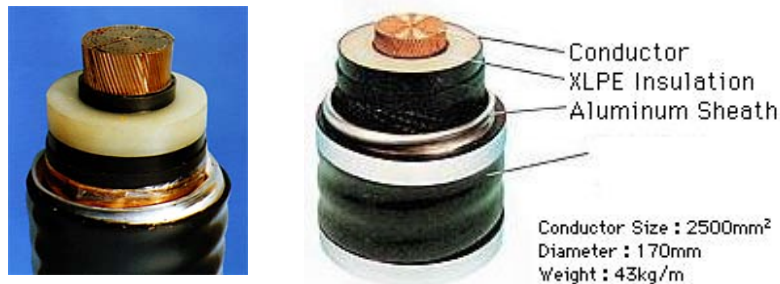
Extruded Dielectric Cable (XLPE or EPR)

Offers a number of advantages compared with the previous types including the absence of pressured systems as well as the ease of splicing, resulting in a less costly installation, precluding potential for environmental risks (leaks), and lower maintenance costs, but useful life questions are more unknown compared with previous systems.

Used extensively for voltages up to 230 kV

May use either copper or aluminum conductor

Available with either XLPE or EPR insulation



**CABLE TYPE AHXLMK 1750 kcmil 115 kV
MAXIMUM STRESS DESIGN**



CONDUCTOR
- nominal diameter 1480 mils
- number of wires 127

Semicon. nylon tape

CONDUCTOR SHIELD
- average thickness 40 mils

INSULATION
- average thickness 590 mils

INSULATION SHIELD
- min. point thickness 40 mils

WATER BARRIER
- semi-conducting swellable tape

LEAD ALLOY SHEATH
- nominal thickness 95 mils

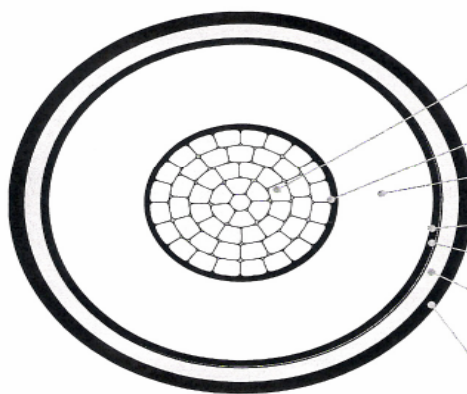
POLYETHYLENE JACKET
- nominal thickness 140 mils

CABLE
Approx. diameter 3.5 "
Approx. weight 9.0 lbs/ft

Photo Courtesy ABB

AHXLMK 1750 kcmil 115 kV

Cable sizes are usually specified in 250 kcmil increments;
i.e. 1000, 1250, 1500, 1750 kcmil, etc)



CONDUCTOR
- nominal diameter 1.480 mils (37.6 mm)
- number of wires 127

CONDUCTOR SHIELD
- average thickness 40 mils (1.02 mm)

INSULATION
- average thickness 590 mils 15.0mm

INSULATION SHIELD
- min. point thickness 40 mils (1.02 mm)

WATER BARRIER
- semi-conducting swellable tape

LEAD ALLOY SHEATH
- nominal thickness 95 mils (2.41 mm)

HDPE Jacket
- nominal thickness 140 mils (3.56 mm)

CABLE
Approx. diameter 3.5 inches (89 mm)
Approx. weight 9.0 lbs/ft (13.4 kg/m)

Courtesy Pirelli
(Prysmian Cables & Systems)

Factors which Influence Cost

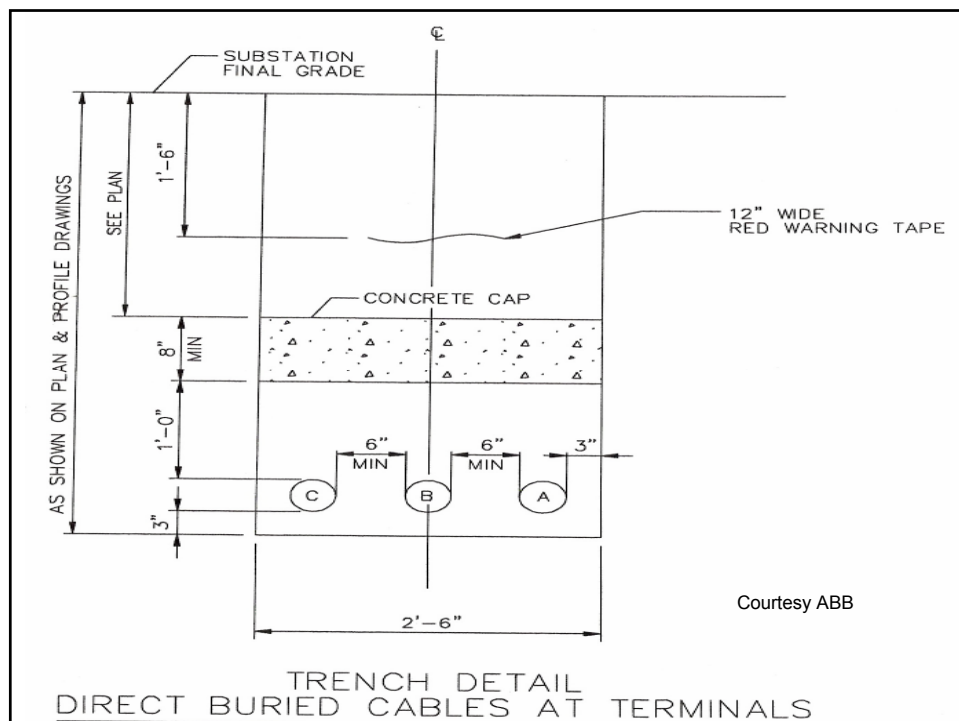
- Size and type of cable, as well as whether direct buried or in conduit
- Length of line (shorter ones are impacted by expensive termination costs)
- Terrain considerations (flat, rocky, steep)
- Presence of other underground utilities
- Number of stream or road crossings
- Need for directional boring (whose costs are significantly higher)
- Right of way costs
- Permitting requirements

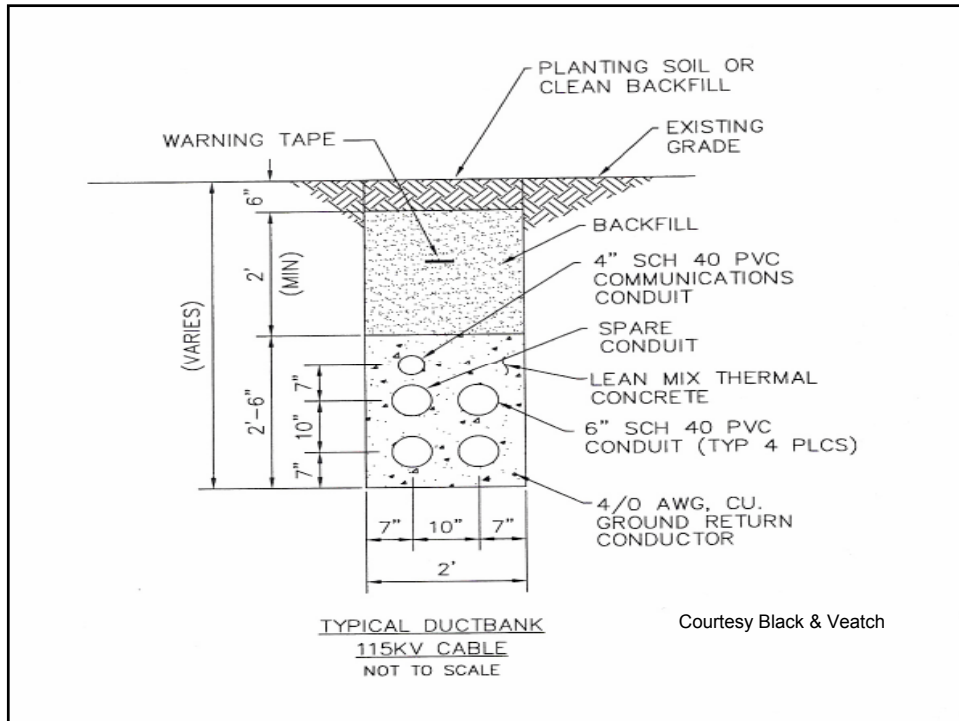
Approximate Costs of Underground Transmission

- For purposes of estimation, recognizing the numerous factors cited in the previous slide, approximate costs could be seen in the following ranges:
 - 115 kV: \$1.0 - \$1.5 million + per mile (installed)
 - 230 kV: \$2.0 - \$3.0 million + per mile (installed)

Underground Construction

- The construction process involves:
 - clearing the right-of-way
 - digging the trench
 - installing the duct bank and vaults
 - covering with thermal backfill
 - pulling cable between vaults
 - splicing cable, install termination points, dead-end structures and surge arrestors.

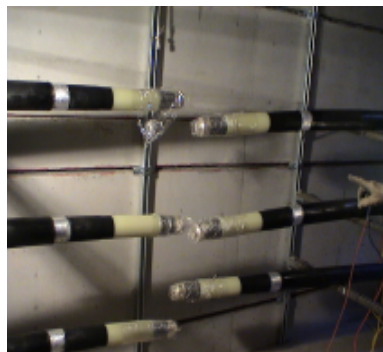








Peeling the insulation



Photos Courtesy Pirelli
(Prysmian Cables & Systems)













Manholes (Vault)

- Their locations will be dependent upon a number of factors including:
 - Cable reel limitations
 - Allowable tensile stress
 - Sidewall pressure on the cable ($\text{Tension out of Sheave} \div \text{Radius of Sheave}$)
 - Elevation changes on the route
 - Access issues for a particular manhole location

Manholes are pre-cast and come in either:

- two sections (top/bottom) or
- three sections (top/middle/bottom).

After backfilling, only a cast iron lid is visible.

Manholes (Vaults) and Splices

- Cost range of a vault might range from \$ 10,000 to \$ 30,000 + (for a 115 kV installation).

Cost range of splices might range from \$ 4,000 to \$ 5,000 + per phase (for a 115 kV installation).













Crossing Roads

Options include:

- a) Jack and Bore Casing - is much more expensive than open cutting the road; however, it permits traffic to flow without interruption.

Pits are excavated on either side of the road and sections of steel casing will then be “jacked” from one end to the other.

- b) Open Cutting the Road - is a much less expensive option but does require traffic control and interruptions.

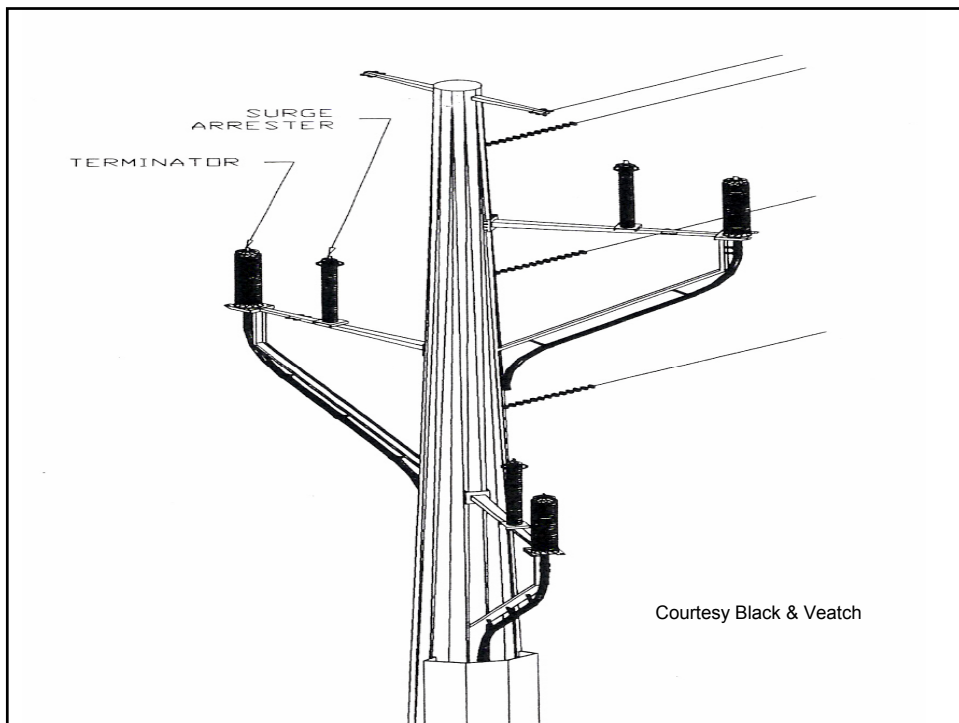






Terminations (i.e. Pothead)

- Each end of the underground transmission line requires a termination device:
 - i.e. stress control mechanism in a sealed, electrically insulated housing.
 - it must provide external insulation between the cable conductor & ground.
- Costs can range from \$ 25,000 to \$ 60,000 + at each end (for all three phases, including labor), but excluding cost of required lightning arrestors and riser poles.
- Critical that these be performed by skilled workers, and warranty provisions likely to be dependent upon this.





























Tests Upon Installation

Tests include:

- a) Phasing Check**
- b) Cable Jacket Integrity Test**
- c) 24 hour Full Line Voltage
Soak Test**

Electric Cooperatives with Underground Transmission

- To date, there has been a very limited amount of underground transmission constructed by rural electric cooperatives due to its high cost relative to overhead.
- I will discuss three transmission projects that have been recently completed in Colorado, including the way in which each were handled by the utility.

Colorado Underground Projects

Voltage	115 kV	115 kV	115 kV
Length	3.2 mi	1.9 mi	.5 mi
Type	Double Cir. XLPE AL	Single Cir. XLPE Cu	Single Cir. XLPE AL
Size	1750 kcmil	1750 kcmil	1750 kcmil
Routing Constraint	Scenic / Land Restrictions	Urban	Urban
U vs. O Multiplier	~ 5	~ 6	~ 4
	(depending upon ROW cost and other cost allocation assumptions)		

Cautionary Point

- It is very important to note that the previously mentioned ratios of underground to overhead costs can NOT be assumed for other projects.
- These ratios are totally dependent upon so many design considerations, as well as local issues, including ROW costs.
- Each potential transmission project should be independently evaluated.

Differential Cost Treatment

- Three different approaches were applied by the particular Colorado system in handling the differential costs between overhead and underground transmission facilities:
 - In one case, the amount was collected in cash from the municipality that required underground service.
 - In the second case, the amount is being collected as a monthly electric surcharge for those consumers served by the substation over its assumed life (35 years).
 - In the third case, the utility will consider the total cost as normal system expansion and collect from all consumers served. There were justifying reasons that required moving ahead with the project and the difficulty in obtaining an overhead easement.

Interesting Aspects of 2nd Option

- The town requiring underground transmission service was given the option of collecting this differential as a monthly electric surcharge calculated as follows:

The owning cost differential between underground and overhead transmission is collected based upon either:

- A flat charge per consumer
- The amount of kWh used by consumers
- The revenue paid by consumers
- A combination of the kWh and revenue methods

In each case, these amounts would be greatest in the initial year of service, and decrease thereafter as the number of consumers and their respective usage increased.

Cable Standards, Warranties

- Applicable standards include:
 - AEIC (CS1-90, CS2-97, CS3-90, CS4-93, CS6-96, CS 7-93, CG1-96, CG2-72, CG3-2005, CG4-97, CG5-2005, and CG6-95) depending upon type of cable;
 - ANSI/ICEA T-27-581, NEMA WC 53 (standard test methods)
 - ASTM B8/231
- These projects specified insulation thickness that ranged from 590 mils XLPE, to 800 mils XLPE (100% insulation level).
- The warranties offered by cable manufacturers typically range from 2 to 5 years, and may possibly be extended to 10 years.
- Warranties are often affected by whether the cable terminations are installed by parties that the cable manufacturer have authorized or not.

“Underground” Policies

It is advisable that any electric cooperative responsible for transmission line construction and ownership, consider adopting a line extension policy as it relates to “Underground Transmission”.

By doing so, the board and management will have had the opportunity to develop appropriate considerations and requirements for potential cost sharing, prior to any inquiry that surfaces.

Just as most electric cooperatives have such policies as they relate to underground distribution, it is advisable to address transmission, should questions arise during project development.

Cost Responsibilities

- Many electric cooperatives as well as other utilities have reached the conclusion that any special requirements beyond that normally provided by the utility should be borne by the specific community that dictates such need.

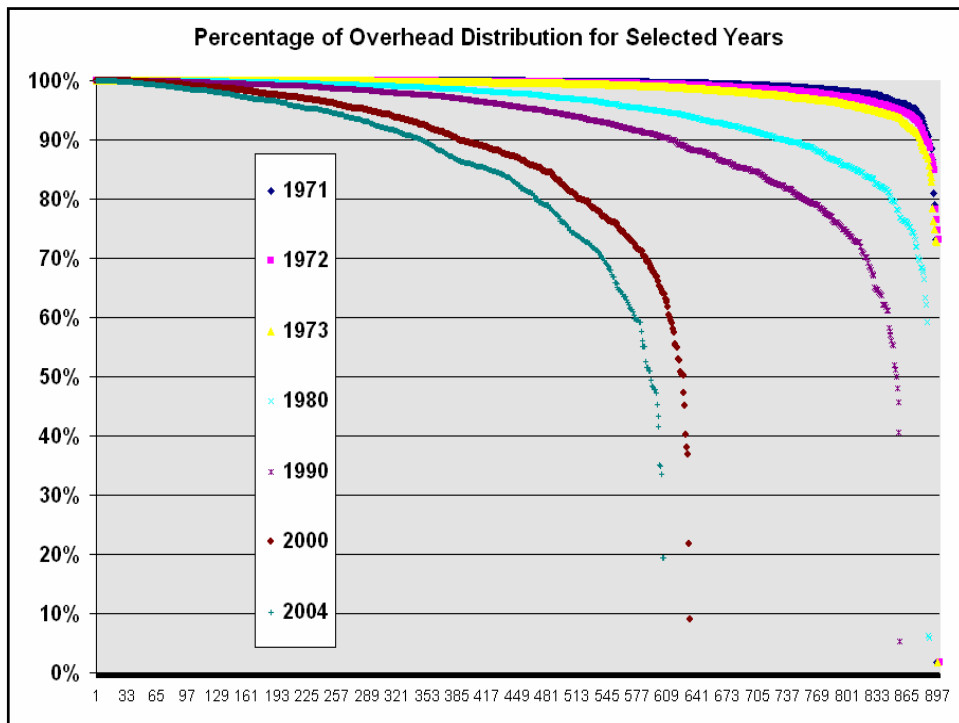
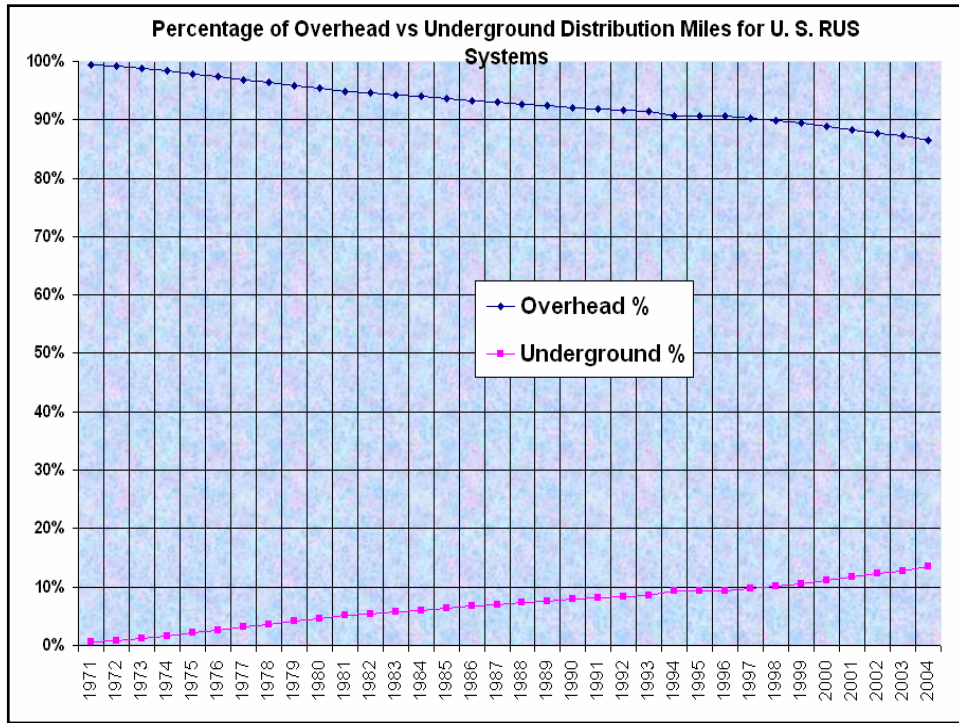
This is based upon the belief that underground is not universally required, or desired, and should not be the cost responsibility of those portions of the system which do not impose such requirements.

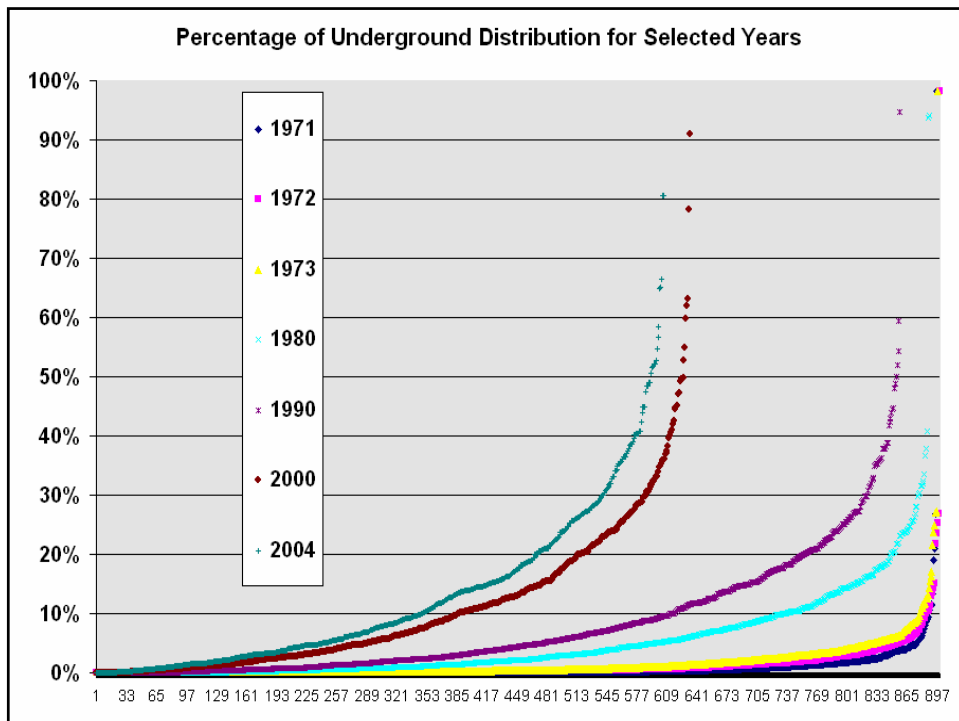
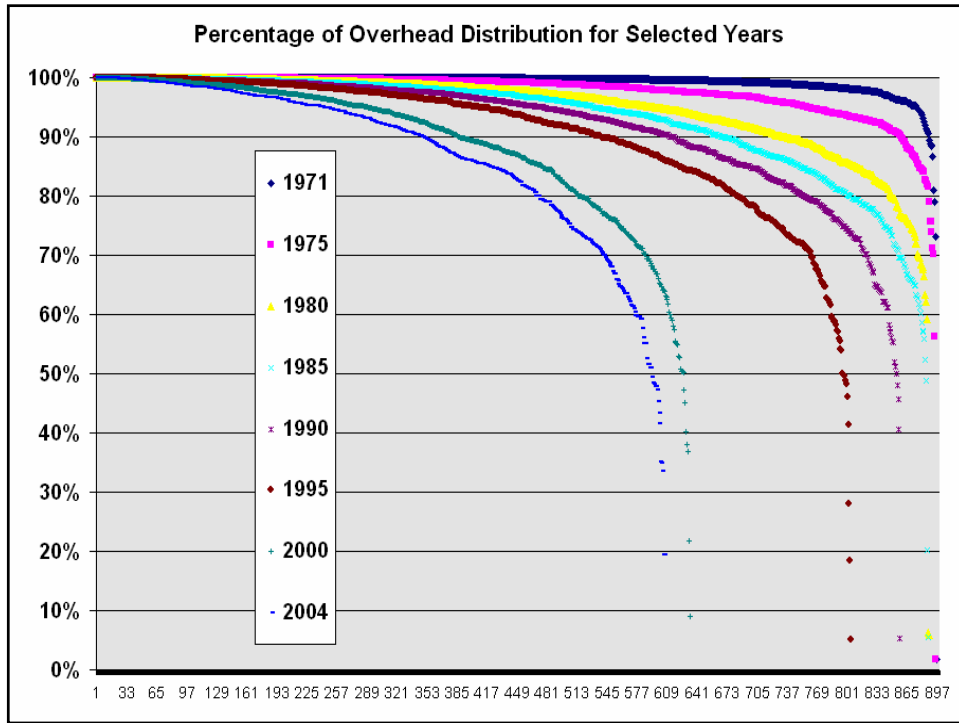
Other Factors to Consider

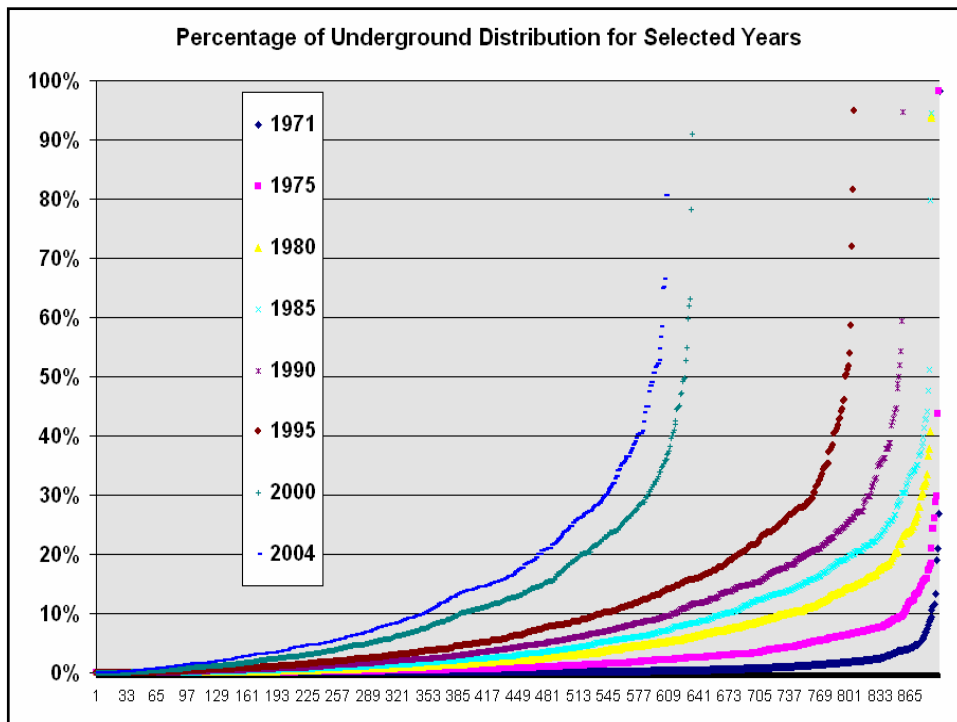
- It is important that the following aspects be considered when an underground transmission project is being evaluated or developed:
 - Utilize Engineering Expertise qualified to design and ensure proper installation
 - Appropriate Cable Testing upon manufacture & installation (ANSI/ICEA T-27-581, NEMA WC 53)
 - Need for Spare Parts
(1 cable reel, 1 cable terminator,
2 cable joints, 1 surge arrester)
 - Maintenance Costs (periodic inspections and jacket integrity tests)
 - Life Expectancy (solid dielectric cables are assumed to have a useful life of 35 years; historic HPFF underground systems continue to be operational well beyond that period).

Underground Transmission?

- The ultimate decision is left to each individual system after recognition of all relevant factors including available options for routing, cost of construction including easements, possible cost sharing, ability to afford such higher costs, as well as numerous other factors mentioned.
- Many formally rural systems are being impacted by issues that have driven greater use of underground distribution construction.
- However, it is a MUCH bigger step to implement underground transmission and will continue to only be seen in rare instances for many years to come.







In Summary

While distribution underground continues
to be increasingly utilized,

there may be limited areas or circumstance that
underground transmission may be installed.

It certainly will not be the “norm” for rural
electric systems in the United States
due to its much higher costs requiring a
highly engineered system.

Hope this information proves to be practical
information when it is being discussed.

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

Modular Substations

**Claes Westring
Substation Systems
ABB, Inc.**

BIOGRAPHICAL SKETCH

Claes Westring

Mr. Westring is ABB's Marketing Manager for their Power System's Division engaged in the development of T&D infrastructure projects. He has over 25 years of experience in providing innovative solutions to the electrical utility industry. Over the last 5 years he has been actively involved in developing the Modular Substation Approach based on RUS Standards for Rural Electric Coop's.

**RUS 2006
Electric Engineering
Seminar**



**Modular Substations
An Innovative Approach**



ABB

Presentation Program

- Air Insulated Modular Substation Concept
 - What is a Modular Substation
 - Modular Substation Factory Assembly Process
 - Site Installation of Modular Substations
- Modular vs Conventional Substation Economics
- Turnkey Modular Substation Projects
- Site Assembly of a Modular Substation

ABB

Coop Market Drivers to Modularization of Substations

- Meeting Growth Demands
 - City's expanding to Coop territories
 - Industrial loads connecting to Coop Systems
- Permitting Process
 - Property acquisitions & permitting delays
 - Interconnect Right of Way delays
- Standardization
 - Ease of Operation
 - Base Design
 - Minimized inventory of spare parts
 - Lower costs



Modular Substations

Open Air bus Insulated Secondaries



Open Air bus Insulated secondaries

Air Insulated metal enclosed bus



Indoor Gas Insulated Bus



MODULAR SUBSTATION CONCEPT

What is a MODULAR Air Insulated Substation ?

- A completely engineered substation system
- Skid mounted substation, factory-assembled and functionally tested
- Custom-designed, built and installed using a standard process
- Flexible design to accommodate RUS & Coop detail requirements
 - All voltages, all ratings, all configurations
 - RUS approved equipment & materials

34.5 kV - 138 kV

5-200 MVA

5 kV - 35 kV

Quality
Flexibility
Dependability



A traditional substation, just put together differently

ABB

Modular Open Bus Air Insulated Substation 115kV /25KV 25MVA



**Radial Primary Tap /
Main & Transfer Secondary, feeder regulated**



Modular Open Bus Air Insulated Substation 115kV/12.47kV 25MVA



Stepped Site , underground transmission connection



Modular Air Insulated Substation 115kV/25KV 20MVA



Looped Primary / Main & Transfer Secondary, Bus Regulated



87.5 MVA 138 kV / 34.5 kV Modular Substation



**Open air insulated single bus secondary,
overhead feeder exits**



Modular Air Insulated Substation 7.5MVA 69Kv/ 25kV



Radial Tap, Main & Transfer ,bus regulated **ABB**
Underground feeder exits

MODULAR SUBSTATION ASSEMBLY

Typical Assembly Process - Assembly of Skids



ABB

15kV Modular Skids during Factory Assembly Process



All switches ,bus and connections are factory installed

ABB

Substation during factory assembly



ABB

Typical Assembly Process - Cable Termination



Cable Pulling

Cable Terminating



ABB

Control Room Control & Protection Panels



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Modular Control Building & Interface Panels

Internally pre-wired



External wiring pre-made and tagged ready to ship

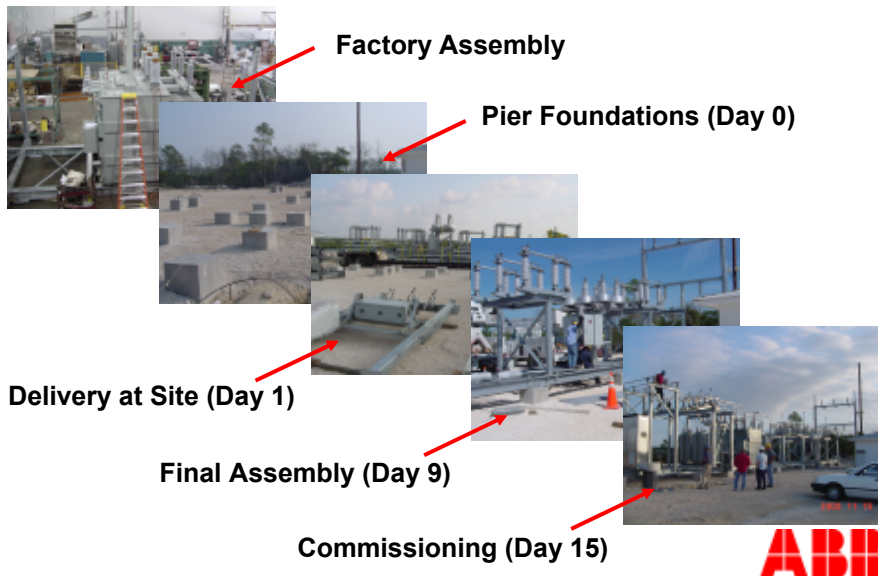
ABB

Recloser Skid in transit to site



ABB

Modular Substation: Start to Finish in 8 months or less

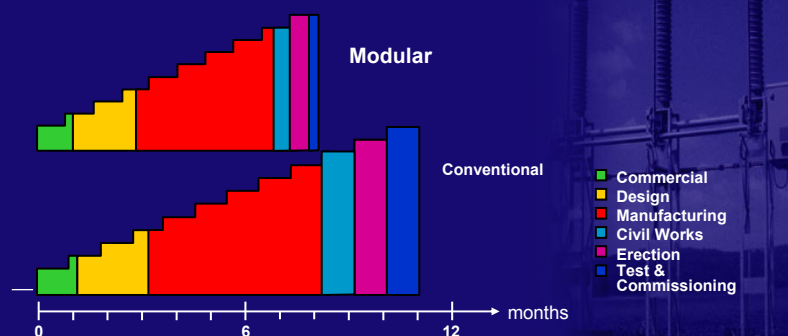


MODULAR vs CONVENTIONAL ECONOMICS

Modular Substation Advantages

MODULAR APPROACH

- Up to 35 % overall project time savings
- Reduced on site installation & Commissioning time



ABB

Modular vs Conventional -Civil Works



Pier type foundations

• Modular :

- Skids support Equipment
- Foundations support Skids
- Less Foundations
- Skid has built in cable tray system
- Minimized underground conduit

• Conventional:

- Foundations support equipment
- Foundation support structures
- Need underground conduit to interconnect control cabling

• MODULAR BENEFITS:

- Up to 40% less cost in foundations and conduits



Modular vs Conventional - Installation



Modular

- Factory Skid Assembly & pre-wiring
- Site assembly in 1-2 weeks
- up to 75% less installation & supervision cost
- Minimized Weather Risk



Conventional

- All structural and equip assembly at site
- All buswork, connections & wiring made at site
- Weather dependent
- Longer Site Time & Higher costs



Modular vs Conventional - Testing & Commissioning



Modular

- Wiring verification at factory
- Site wiring functional testing minimized to hours
- Buswork and connections verified at factory and rechecked at site
- 75% less verification time at site



Conventional

- All wiring installed & verified at site. Highest potential for delays and rework
- All buswork, connections made and verified at site
- Weather dependent
- Longer Site Time & Higher costs



Modular Substation Projects (2001- 2005)

■ Utilities:

■ Coop's:

- | | |
|---------------------------------|------------------------------|
| ■ San Isabel (SIEA), Pueblo, CO | 5-115kV Modular Substations |
| ■ Gunnison (GCEA), CO | 115KV Modular Substation |
| ■ Kit Carson (KCEC), Taos, NM | 69/25kV Modular Substation |
| ■ Jemez (JMEC) Espanola, NM | 69/12.5kV Modular Substation |
| ■ West Plains Electric, ND | 42kV Modular Substation |

■ IOU's:

- | | |
|------------------------|------------------------------|
| ■ Keyspan, Long Island | 14-69kV Modular Substations |
| ■ Duke Power | 100kV Modular Substation |
| ■ TXU, Dallas, TX | 3- 138kV Modular Substations |



ABB Turnkey Projects - cont'd

■ Industry:

- | | |
|----------------------------------|----------------------------------|
| ■ Georgia Pacific, Lynchburg, VA | 69 kV Modular Substation |
| ■ Walgreens, Toledo, OH | 115kV Modular Substation |
| ■ eCorp, Owego, NY | 115kV Modular Substation |
| ■ Nippon, Dallas, TX | 138kV Modular Substation |
| ■ Bristol-Myers Squibb, NJ | 69kV & 115kV Modular Substations |

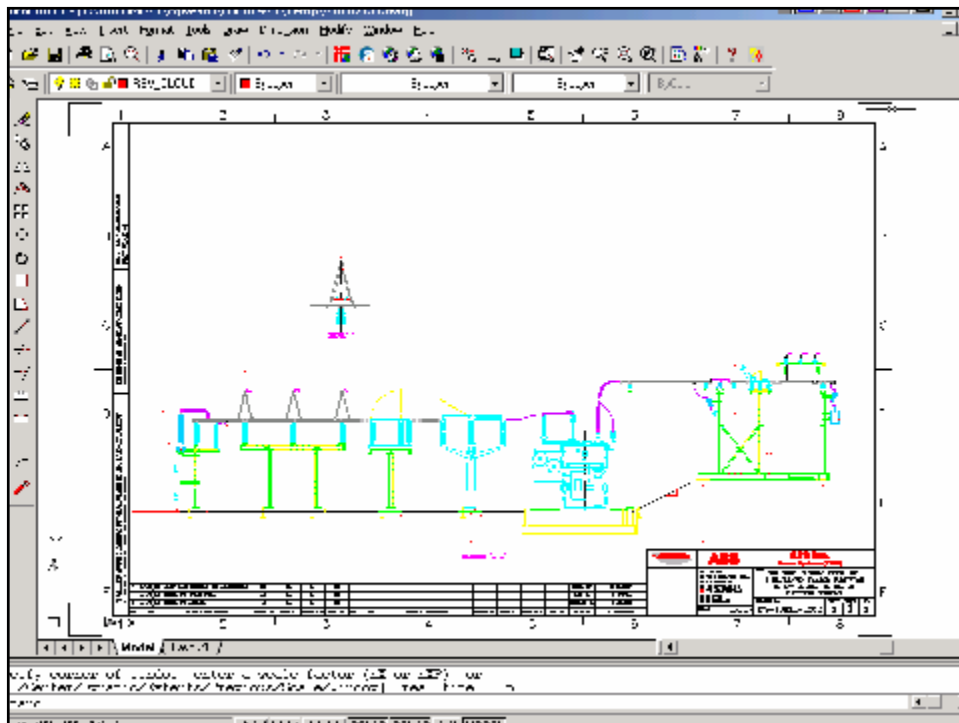
■ Developers:

- | | |
|-------------------------|------------------------------|
| ■ RES Wind, McCamey, TX | 6- 138kV Modular Substations |
| ■ UPC Wind, Hawaii | 1- 69kV Modular Substations |
| ■ RES, Sweetwater, TX. | 1- 138kV Modular Substation |



Modular Substation Project during Site Installation





Substation during factory assembly



ABB

Installation Preparation

May 5, 2003

Day 1 6:00 AM



ABB

Arrival of Control Building Skid

May 5, 2003

Day 1 6:30 AM



ABB

Arrival of 12.47kV Feeder Skid



ABB

Unloading Building Skid



ABB

Unloading Skids



ABB

Unloading Recloser Skid



ABB

Unloading Regulator Skid



ABB

Assembling Low Side Modular Skids



ABB

Completed Low Side Modular Skid Assembly

May 5, 2003

Day 1 12:15 PM



ABB

End of Day One

May 5, 2003

Day 1 5:00 PM



ABB

End of Day One



ABB

Start of Day Two



ABB

Assembling Low Voltage Bus



ABB

Assembling 115 kV Circuit Switcher



ABB

End of Day Two

May 6, 2003

Day 2 5:00 PM



ABB

Assembling LV Bus

May 7, 2003

Day 3 3:00 PM



ABB

Assembling HV Bus Work

May 8, 2003

Day 4 2:00 PM



ABB

Completed Bus Work

May 9, 2003

Day 5 2:00 PM



ABB

Completed Regulator Maintenance Skid

May 9, 2003

Day 5 2:00 PM



ABB



ABB



115kV /12.5kV 25MVA Modular Substation



**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

Geographic Information Systems


**Keith Mitchell
GIS Specialist
Engineering and Environmental Staff**

BIOGRAPHICAL SKETCH

Keith Mitchell

Mr. Mitchell, a native of Northern Illinois, received his Bachelor of Science degree in Soil Science in 1990 from University of Illinois and a Master of Science degree from University of Illinois in Environmental Water Quality Modeling in GIS in 1994. After graduation he worked for the US Army Corp of Engineers' Geographic Resource Analysis Support System (GRASS) / Threatened and Endangered Species (TES) Interface project. This was followed by several months working for the University of Illinois as a GIS Professional in the school of Agricultural Engineers. Mr. Mitchell spent a year working for the Jicarilla Apache Tribe in New Mexico initiating a tribal owned GIS. Following New Mexico was a position held for three years in his native Illinois working for the State's Department of Natural Resources, Natural Heritage Division.

Mr. Mitchell entered Federal Service for the Department of Interior, Bureau of Indian Affairs, in 1999 in Gallup New Mexico working in Navajo Region. He accepted a position with Rural Development in June 2004.



G I S

The diagram shows the letters G, I, and S in a light blue font. A curved arrow points from the letter 'S' to the letter 'I', and the word 'Analysis' is written in red above the arrow.

Geographic Information System

What is GIS?

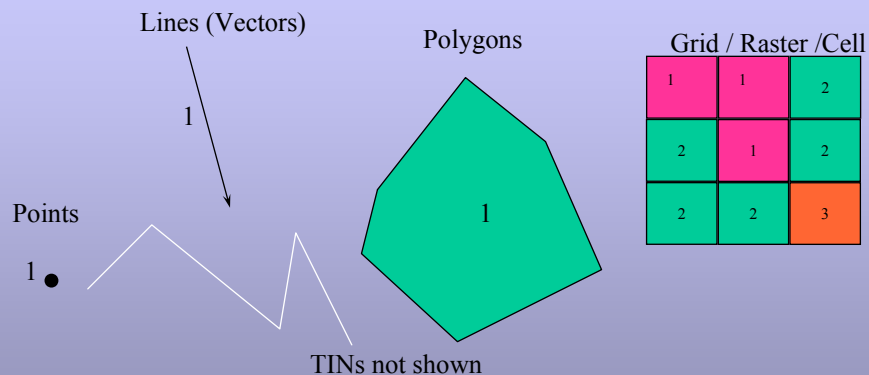
Geographic Information Systems

- A system comprised of hardware, software, data, people and processes for managing and analyzing spatial data
- Objective: to improve decision making

What is a GIS (the RD details)?

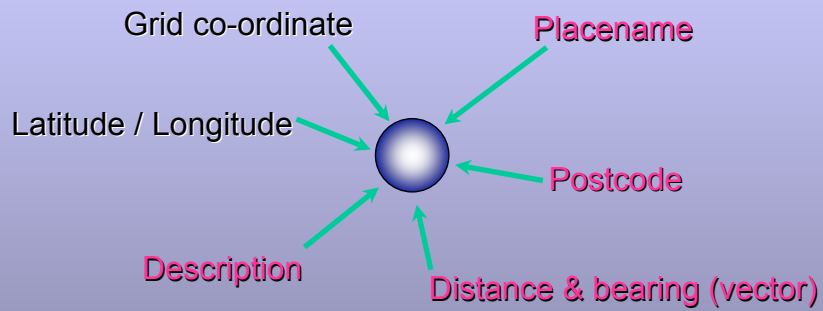
- **people** **Agency loan specialists, managers, GIS professionals**
- **data** **Project information, databases, images, raster, map layers**
- **hardware** **PCs, hard drives, tape drives, portable drives, GPS units, servers**
- **Software** **ESRI products- ArcGIS, Arc Explorer, ArcIMS, SDE, ArcServer, : UNIX, Windows, Linux**
- **Procedures** **Scripts, step-by step instructions, “path directions”**

The Elements of a GIS



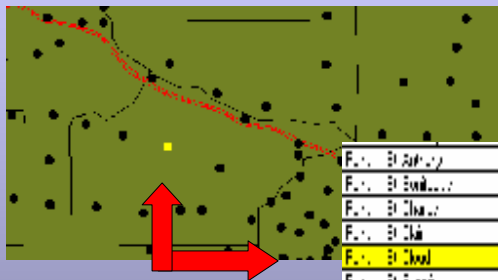
Key	Type	Disaster_title	Assistance
1601	Tropical Storm	Tropical Storm Cindy	ABCDEFGF
1595	Hurricane	Hurricane Dennis	ABCDEFGF

What makes Data Spatial?



Spatial to Tabular Link

Spatial Component:
Polygons, Lines, or Points



Tabular Component:
A Database with
Records and Fields

F... St. Peter's	...	H1	27	2252	30	5	1
F... St. Peter's	...	H1	27	2252	418	2	2
F... St. Peter's	...	H1	27	2252	1037	2242	5
F... St. Peter's	...	H1	27	2252	224	222	3
F... St. Peter's	...	H1	27	2252	18828	4222	6
F... St. Peter's	...	H1	27	2252	800	2222	5
F... St. Peter's	...	H1	27	2252	130	222	5
F... St. Peter's	...	H1	27	2252	1881	4224	5
F... St. Peter's	...	H1	27	2252	779	2224	5

Attributes/Tabular

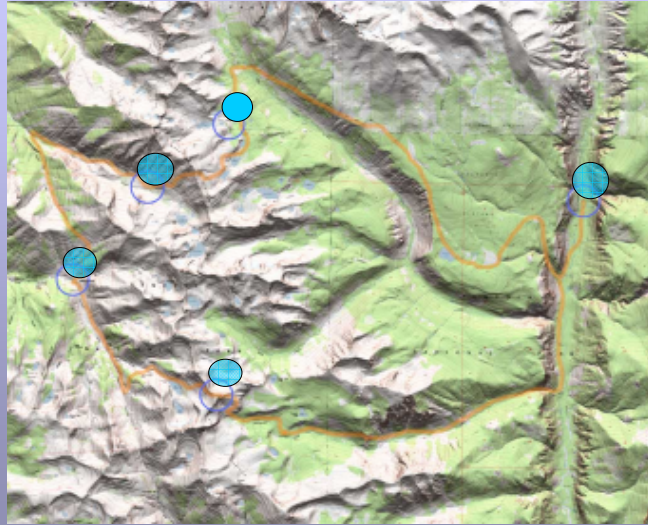
- **Tabular data—adding information to map's tabular data is information describing a map feature. For example, a map of customer locations may be linked to demographic information about those customers.**

Examples of Data Layers

- | | |
|-----------|---|
| •points | •Borrowers, facilities, substations, poles |
| •lines | •roads, streams, utility transmission lines |
| •polygons | •Urban Areas, Service Area, habitat, watersheds |
| •raster | •DRGs, DOQQs, satellite imagery
Elevation grids (DEMs) |

Vector on Image Data

Service Area
Mapping



Digital Image Terminology

DOQ's - Digital Ortho Quadrangles

DOQQ's - Digital Ortho Quarter Quadrangles

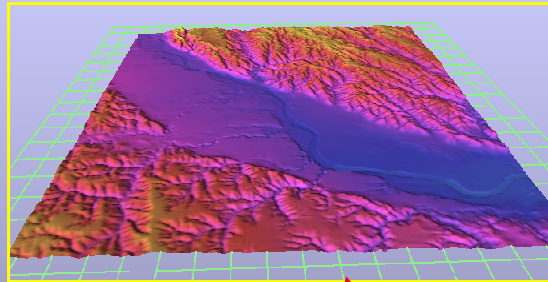


What is a DOQ and DOQQ?

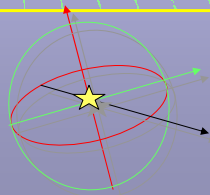
A **DOQ** and a **DOQQ** are comprised of a series of scanned aerial images that have been mosaicked, **tone-matched** and **projected** to an electronic representation of the earth's surface to form a product that has the same amount of geographic accuracy in the **center** of the imagery as the **exterior** edges. Each **DOQQ** is one-fourth of a **DOQ** ($7\frac{1}{2}'$ Geographic Grid.) Therefore, each **DOQQ** is divided into four (4) $3\frac{3}{4}'$ by $3\frac{3}{4}'$ quadrants. Thus the term, **quarter** quadrangle refers to a quarter of a full-quadrangle of geographic space.

Digital Image Technology

DEM's - Digital Elevation Models



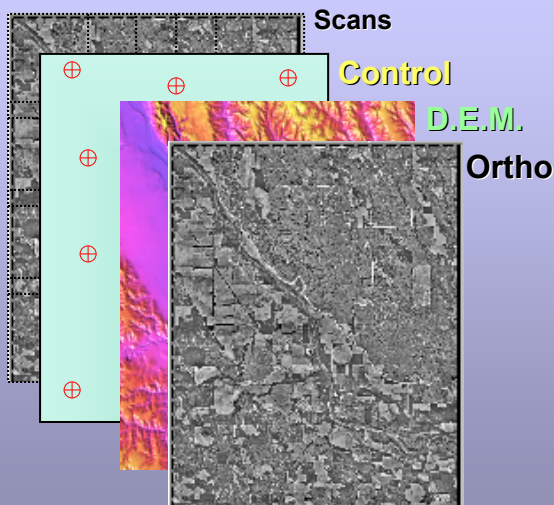
X: Easting
Y: Northing
Z: Elevation



Digital Elevation Models or **DEM's** are raster data that represent the terrain or slope of a given area in a mathematical model where readings are gathered in a uniform manner. **DEM's** are registered to the ground through a geographic projection. **DEM's** have three coordinate readings;

X, Y, Z.

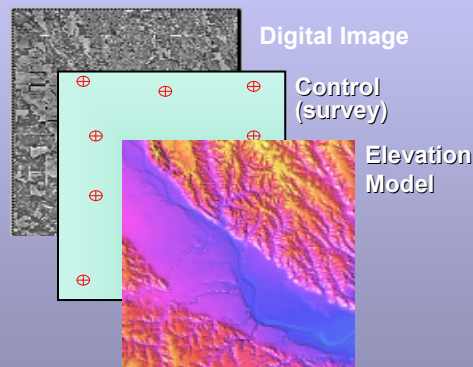
How Digital Ortho Images Are Created:



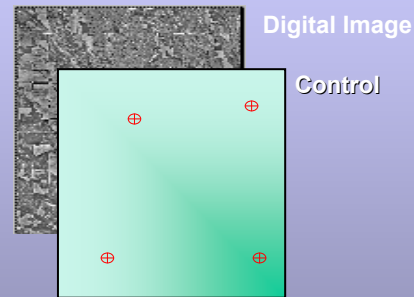
Digital Ortho Imagery is created by taking scanned images (i.e. NAPP Film), incorporating control points derived from GPS or from digital/paper topographic maps. By draping the imagery over a Digital Elevation Model (DEM), the software then projects the control points, DEM, and imagery and creates a Digital Ortho Photograph.

Definitions

Ortho Rectified



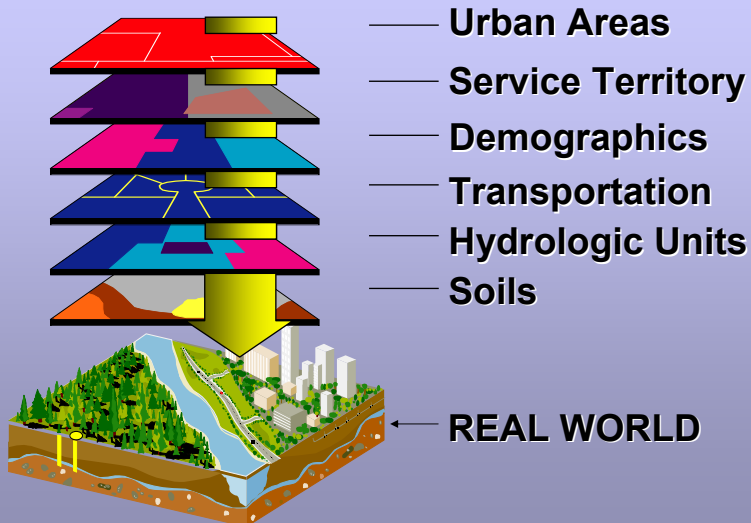
Rectified



How does a GIS Function?

- GIS functions in layers
- A GIS functions with a spatial element (the layers) and a tabular element (the attributes), together providing quality output maps with meaningful information
- The spatial element of GIS are layers comprised of points, lines and polygons, which make-up the map
- The tabular element of GIS is a tabular database filled with attributes for the points lines and polygon.
- These attributes store meaningful information about the spatial features

Layers



What do you do with GIS?

- | | |
|--------------------------|--|
| •Analysis | Assignment of borrowers to agent, |
| •Build spatial databases | Borrower location, eligibility, disaster areas |
| •Create overlays | soils on slope soils on streams buffers |
| •Numerical reports | Area, per capita income, demographic information |
| •Print maps | base maps, incident snapshots |

In general: What can a GIS Do for You?

- ☐ **Perform Geographic Queries and Analysis**
- ☐ **Improve Organizational Integration**
 - Improved management of resources
 - Interdepartmental information sharing and communication
- ☐ **Maps, Modeling, and Analysis**
 - Geographic visualization of corporate assets
 - Digital continuous and scale-free cartographic GIS database
- ☐ **Make Better Decisions and Create Better Solutions**
 - Tools to query, analyze, and map data in support of the decision-making process
 - Reports, have hard and soft-copy reports of spatial data activity

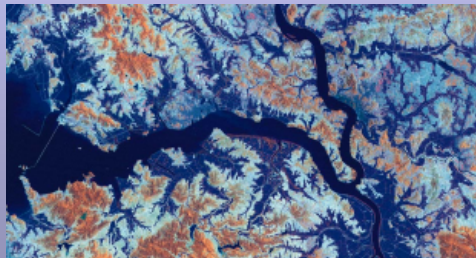
Analysis Examples

- Line Shortest distribution line to customer given impediments such as wetlands are in path
- Point Distance to nearest substation
- Polygon Change in rural house densities over time
- Raster Line of sight-who will see this tower

How GIS Operates!

- Computer-based tool for mapping and analyzing features that exist and events that happen on earth
 - Integration of common database operations with visualization and geographic analysis
 - Create maps and visualize aspatial and spatial data together
 - Visualize scenarios
 - Develop planning strategies
 - Predict outcomes
 - Solve complicated problems
 - Present powerful ideas
 - Develop effective solutions

Everything in USDA is linked by geography.



Before GIS we had maps

What Are Maps?

Maps are tools that provide us with information about the world in which we live. Maps have three principle uses:



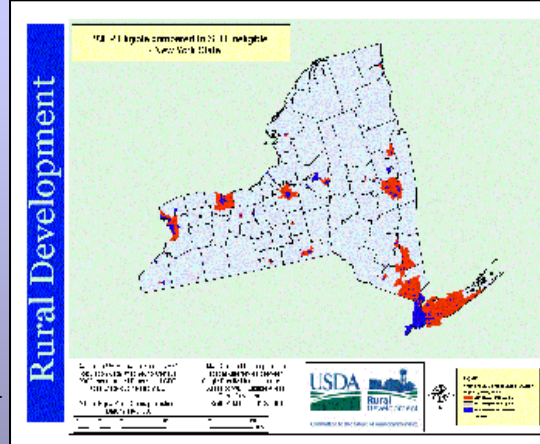
12th Century map of the Mediterranean

- To **locate** places on the surface of the earth
- To show **patterns of distribution** of natural and man-made features
- To **compare** and **contrast** map information and thereby discover relationships between different phenomena

A MAP IS A MODEL OF THE REAL WORLD

Why does RD use GIS?

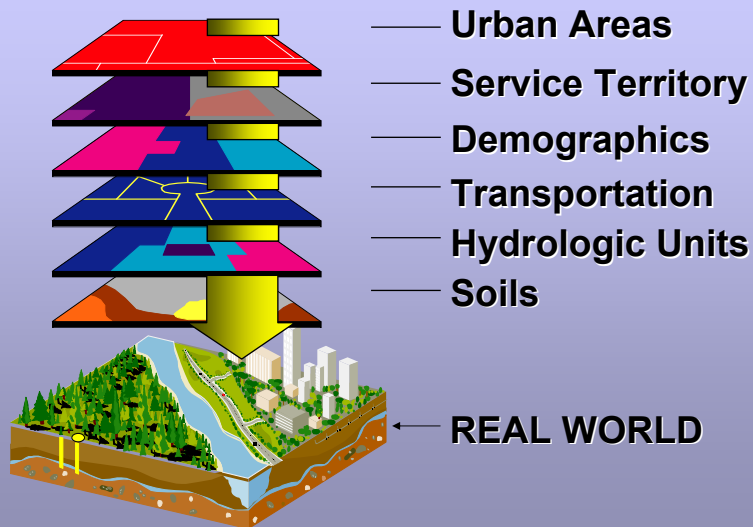
- Supporting loan applications
 - funding eligibility determinations
 - funding allocation
 - decision making
 - environmental review
 - engineering review
- Analyzing RD Data Warehouse Data for Program Efficacy
 - Responding to OMB's Program Assessment Rating Tool (PART)
 - Trend analysis
 - Certify program compliance
 - Assess Data Quality
- Monitoring and modifying changing urban-rural definitions
- Managing State Office Resources
- Tracking customers
- Enhancing reporting capability
- Enhancing training capability



Our benefits of GIS include:

- Better information management
- Higher quality analysis
- Ability to carry out “what if?” scenarios
- Improve project efficiency
- Easy reproduction of our maps to allow working/use copies

GIS Integrates All the Parts



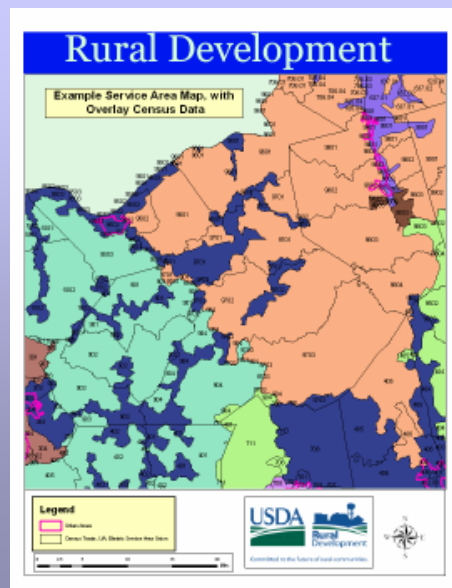
GIS Business Payoffs

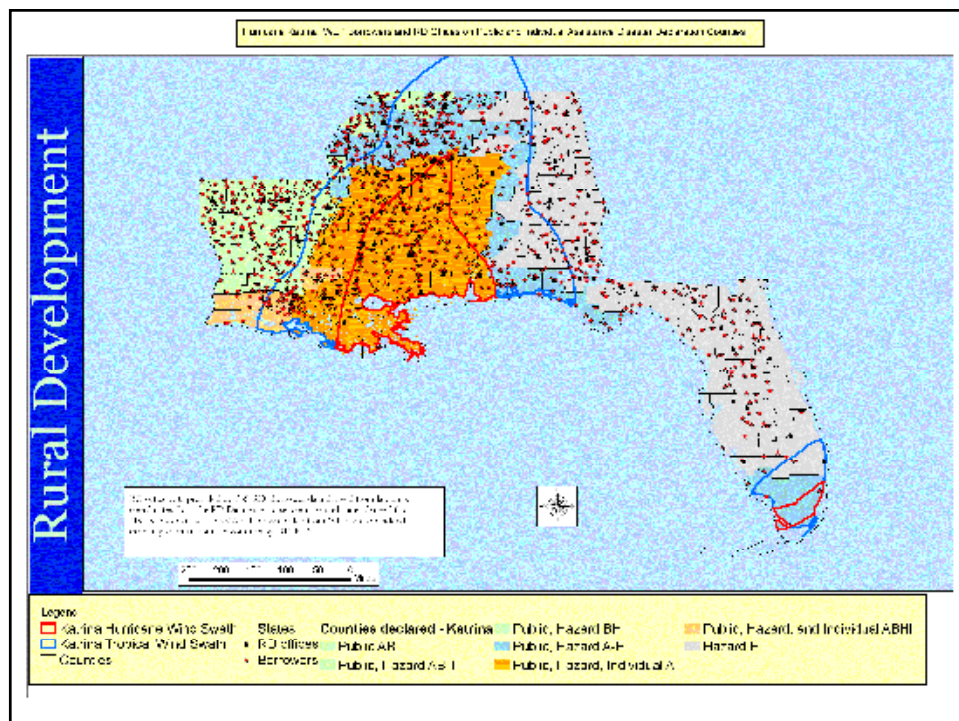
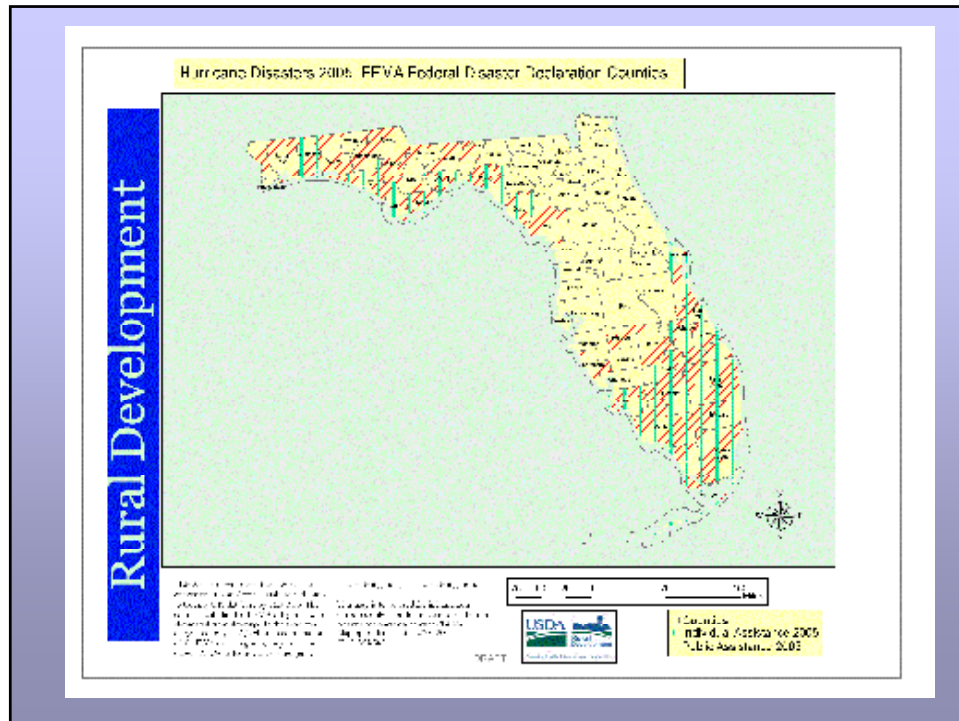
- Accurate and timely information for decision-making and other analytical tools
- Faster flow of information when linked to existing systems (90% of business data has a geographic component)
- Easy access to project related information
- Enterprise (RD) wide availability

National GIS Function

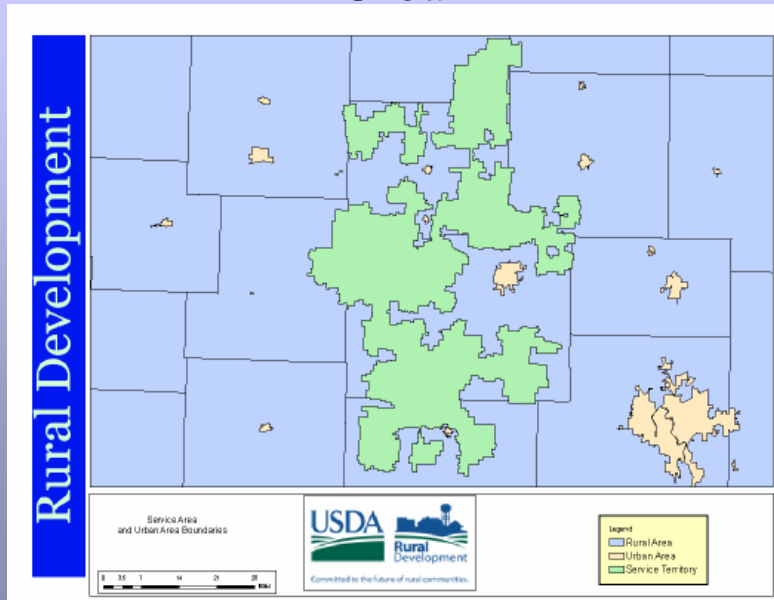
- | | |
|--------------------------|---|
| •Analysis | Eligibility comparisons |
| •Data Development | WEP borrowers, Hurricane supplemental |
| •Procedure Development | FEMA import, |
| •Technical Support | Training, program advice |
| •Development | Standard maps for WEP, templates
special use maps, procedure development |
| •Application prototyping | Eligibility locator, FEMA disaster
counties, RD location browser |
| •GIS Program Analysis | Needs lists, system architectural and
software application needs |

Example of Service Territory map



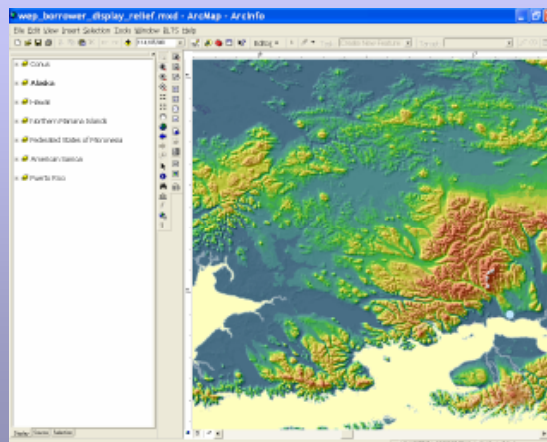


Example Service Area compared to Urban



CCE Approved Software

- ArcGIS Software
- Data Viewers
- ArcGIS Extension Tools
- Web-enabled options



GIS Project Model

- Define your problem
- Determine your data requirements
- Build or Acquire your database
- Design process or model to obtain results
- Run model
- Produce your output

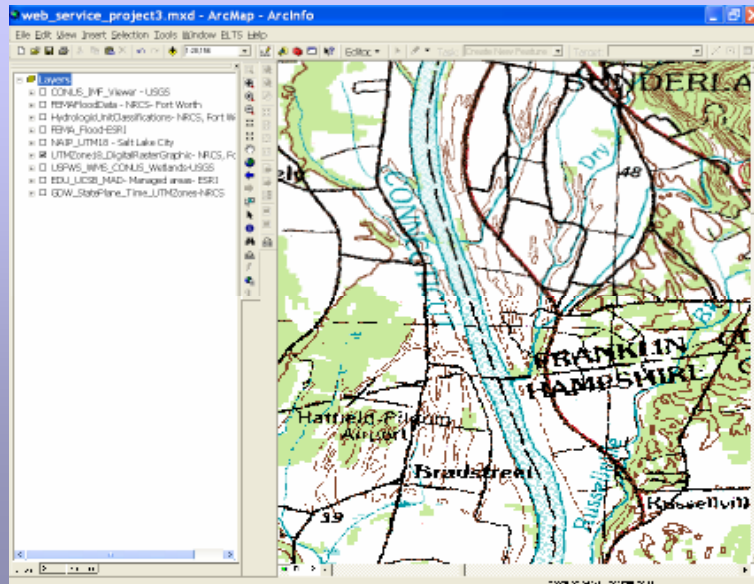
Data Web Services

Data sources not stored locally but obtained on the fly from other servers

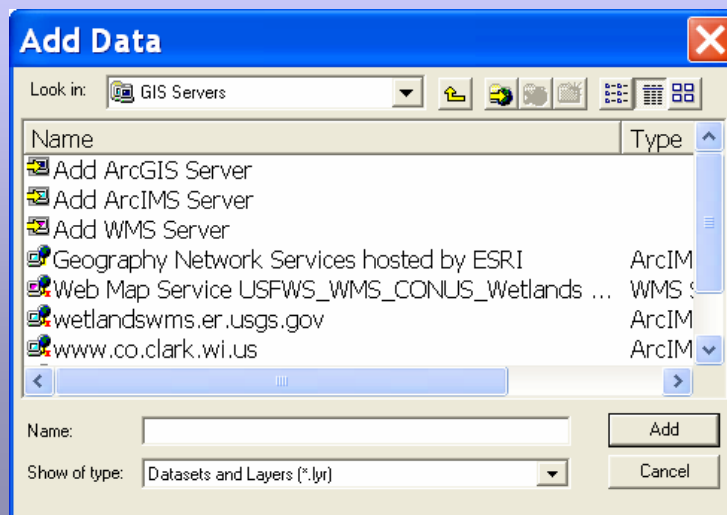
This allows:

- Getting current data from an authoritative source
- Avoid data development and maintenance
- Avoid data related costs

Web Service Example



“Consuming” Web Services in ArcGIS



Data Resources

- **Aerial Photography Field Office-
Salt Lake City, UT**

Web Services-<http://gdw.apfo.usda.gov>

- **National Cartography Geospatial Center-
Fort Worth, TX**

Web Services-<http://wms.ftw.nrcs.usda.gov/>

- **US Census:**

<http://www.census.gov/geo/www/cob/index.html>

- **United States Geological Survey**

<http://nationalmap.gov/>

<http://eros.usgs.gov>

Web Services-<http://wetlandswms.er.usgs.gov>

<http://www.usda.gov/nas/electric>

GIS Resource Portal Link

Welcome to the Electric Programs GIS Resource Portal Link. This site provides a link to the United States Department of Agriculture's Geospatial Data Gateway to enable quick and easy access to GIS maps, their associated data, and other GIS related information. The other site below is a link to Geodata.gov, which is a portal site known as the Geospatial One-Stop (GOS) public gateway for improved access to geospatial information data under the E-Government initiative. The GIS Resource Portal Link is designed to facilitate communication and sharing of geographic data and resources. These links include a catalog of geospatial information containing thousands of metadata records (information about the data). These URL links enable the user to search the database of geographic Metadata, downloadable data sets, images, map files, and more. The Electric Programs are providing these links to GIS services to enable the public to access authoritative and timely GIS data.

USDA Geospatial Data Gateway (NRCS, FSA, RD)

The Geospatial Data Gateway provides One Stop Shopping for natural resources or environmental data at anytime, from anywhere, to anyone. The Gateway allows the user to choose an area of interest, browse and select data from the catalog, customize the format, and have it downloaded or shipped on CD:

<http://datagateway.nrcs.usda.gov/>

Geodata.gov

Geodata.gov is a geographic information system (GIS) portal, also known as the Geospatial One-Stop (GOS), which serves as a public gateway for improving access to geospatial information and data under the GOS E-Government initiative. Geospatial One-Stop is one of 24 E-Government initiatives sponsored by the Federal Office of Management and Budget (OMB) to enhance government efficiency and to improve citizen services:

<http://gos2.geodata.gov/wps/portal/gos>

US Census Files:

<http://www.census.gov/geo/www/cob/index.html>

United States Geological Survey files

<http://seamless.usgs.gov/>

<http://datagateway.nrcs.usda.gov/>



Contact

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**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

Implementing GIS

**Dennis Mabe
System Planning Engineer
Randolph Electric Membership
Corporation**

BIOGRAPHICAL SKETCH

Dennis Mabe

Dennis Mabe is the System Planning Engineer at Randolph EMC where he has been working for 13 years. Dennis graduated from NC State University with a BS in Electrical Engineering in 1992. He is also a registered Professional Engineer in North Carolina.

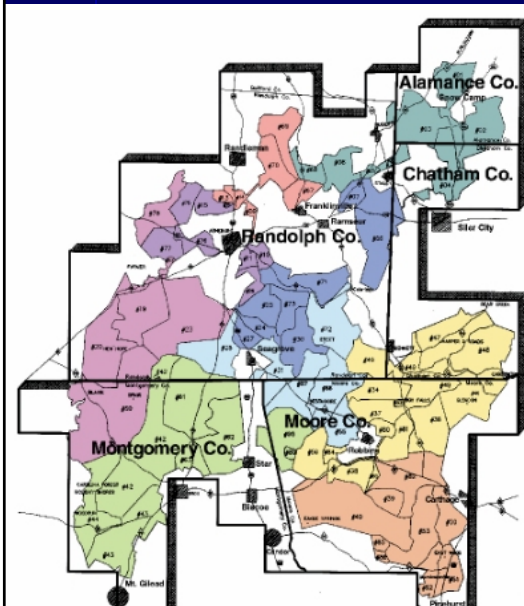
RUS 2006 Engineering Seminar



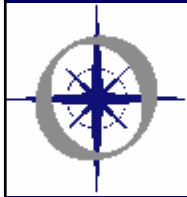
Implementing GIS

Dennis Mabe
Randolph EMC

REMC Territory



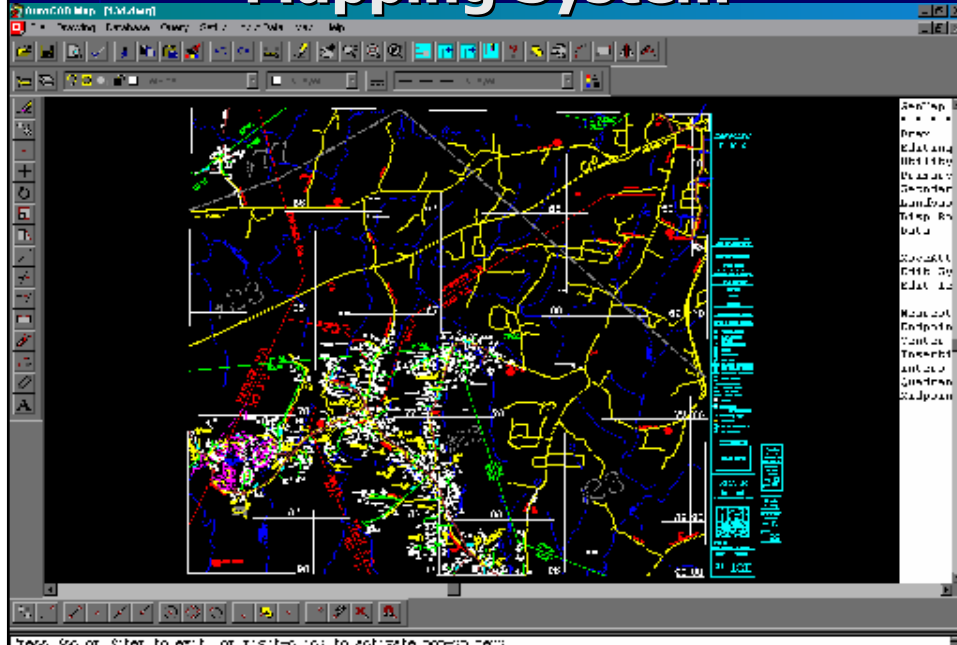
- Service Area in the Center of North Carolina
- 31,000 members
- Parts of 5 counties
- 21 Substations
- 72 Feeders
- 80,000 poles
- 4,400 miles of line



Existing Mapping System

- Started first digitized maps in 1989
- AutoCAD – Gentry Systems
- Approximately 80 individual maps
- System field drawn on digitized USGS Maps NCNAD27

Mapping System





PARTNER
software

Automated Staking

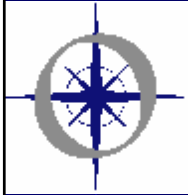
- Implemented automated staking with existing AutoCAD maps
- Integration with CIS
- Map Viewing Capabilities



PARTNER
software

Automated Staking

- Realized benefits early on
 - Time savings
 - One time entry of data
 - Automated process of assembly data
 - Improved Accuracy
- Realized the need for change in base maps



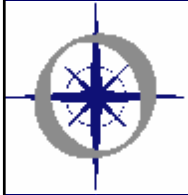
Things we wanted from existing system

- One stop shop for updating facility data
 - STOP the multiple entries of the same data
- Reporting Capabilities
- Interfaces
 - Import Staking drawings
 - CIS
 - Engineering Analysis



Decision to Implement GIS

- Strategic Planning Committee
 - Existing System not able to meet goals
 - Lay the ground work for future needs
 - Detailed Engineering Model
 - Intelligent Staking Data
 - Implementation of Outage Management
 - Complete Integration of necessary Data



GIS Benefits

- Seamless Map of Distribution System
- Asset Database
- Electrical Connectivity Model
- Tool for Analysis and Reports
- Integration with other systems
 - CIS
 - Automated Staking
 - Engineering Analysis
 - Outage Management



Decision Process to Implement GIS

- Vendor search
 - Reviewed GIS products from several vendors
 - Narrowed search to 2 vendors
 - In house demonstrations
 - Site Visits
- Selected Origin GeoSystems

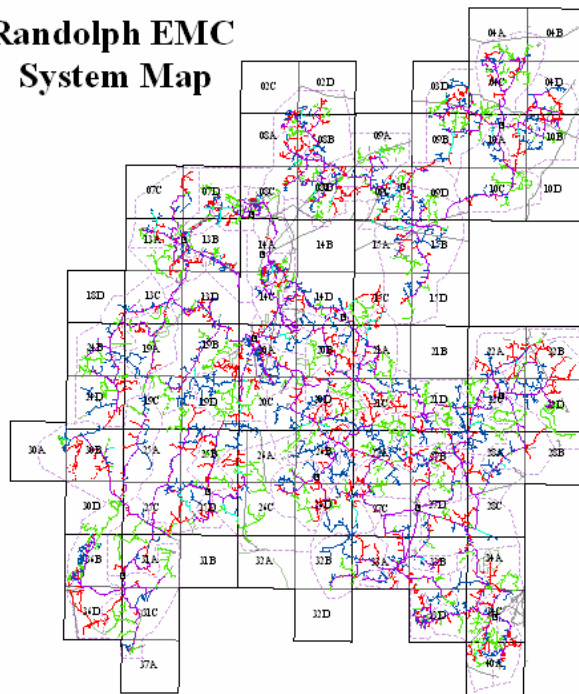


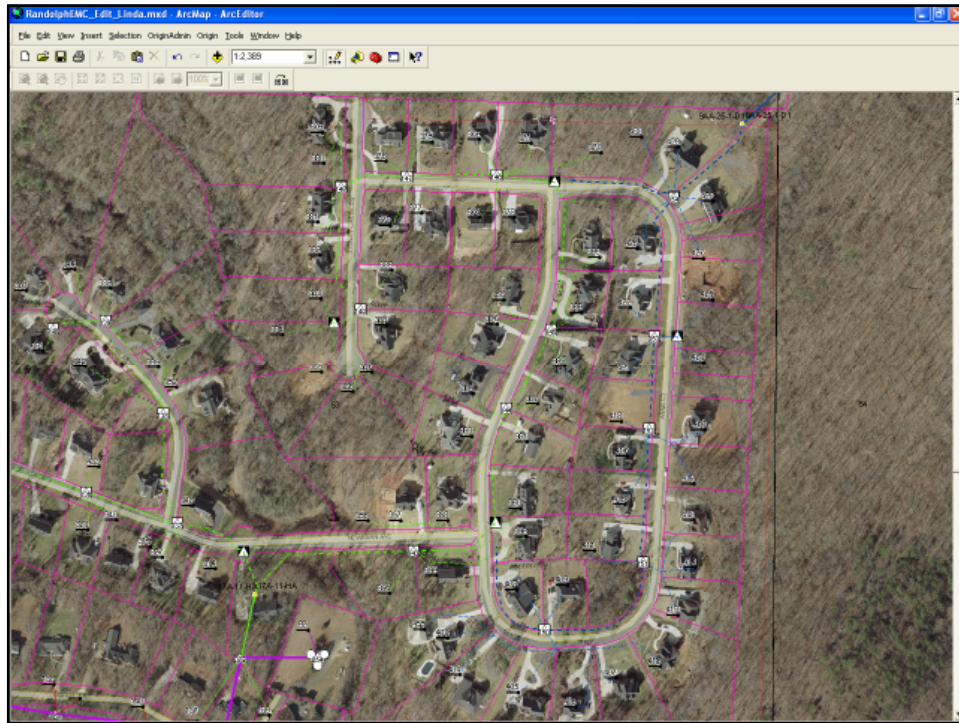
Implementation

- Identified current goals and needs from GIS
- Compiled data sources for conversion
 - CAD drawings
 - Access databases
 - Text files
- ArcSDE
- Determined Network Features
- Initial Custom Symbology
- Froze updating of AutoCAD Maps in July
- Seamless System installed in December



Randolph EMC System Map

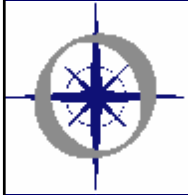




GIS - Initial Lessons Learned



- What do we do with it?
 - Initially failed to take advantage of new system
 - Personally didn't take any ESRI training prior to installation
 - Didn't allow for the intimidation factor for CAD users
- Two additional days of training fixed these issues



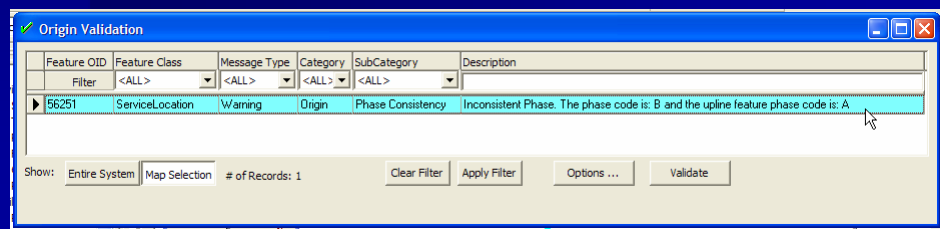
Data Clean Up

- GeoDatabase is only as good as the data you put in it
- Made decision to clean up data internally
- Origin provides excellent tools for validating data



Data Clean Up

- Origin Validation
 - Identifies all electrical and data model rules violations
 - Sort and manage errors
 - Navigate and correct errors





Benefits of GIS

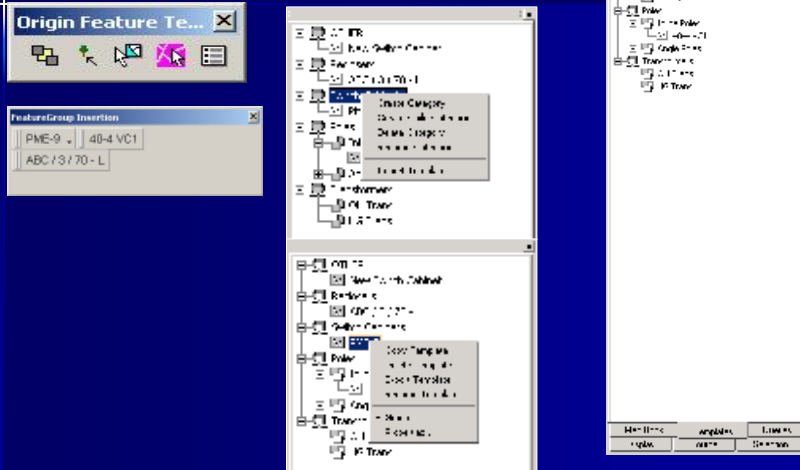
- Seamless Map of Distribution System
 - Complete System at your fingertips
 - No more XREF'ing
 - Multiple users editing the data simultaneously
 - Conflict resolution



Benefits of GIS

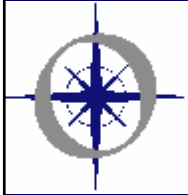
- Asset Database
 - Maintain unit data
 - Ability to create feature templates
 - Provides background maps and existing facilities for Partner Staking

Feature Templates



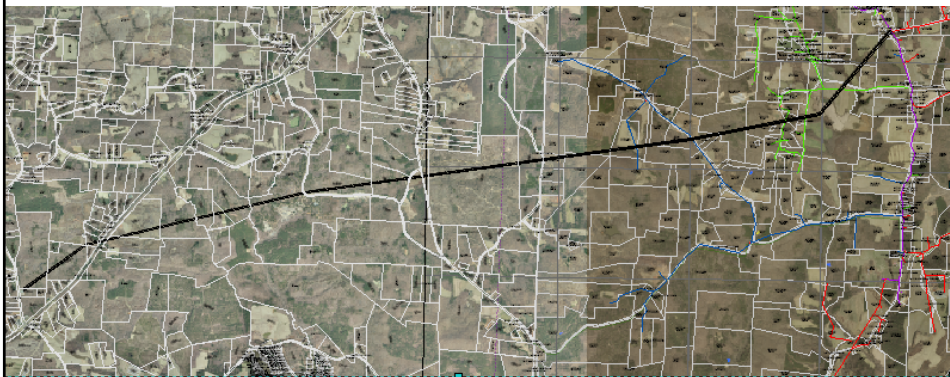
Benefits of GIS

- Electrical Connectivity Model
 - Flow of Electric Distribution System
 - Allows for Tracing Upstream and Downstream
 - Enables us to spot data entry problems early



Benefits of GIS

- Tool for Analysis and Reporting
 - Return results of tracing as drawing or selection
 - Report data based on Attributes
 - Stored Queries
 - Complete export functions for this data
 - HTML, Spreadsheet, Email
 - Easily Add third party data
 - North Carolina One Call



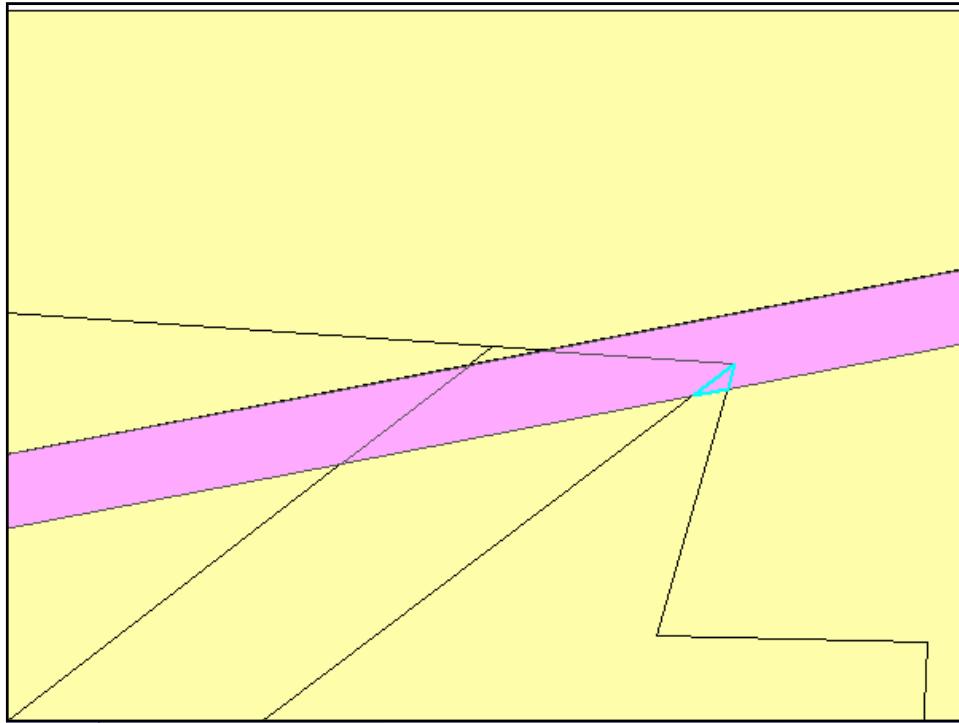


Table of Contents

- OTHER
 - ☒ Fire District Data Query
 - ☒ Distance To Source Report
 - ☒ PDB Upline Tree Report
 - ☒ Feeder Distance Report
 - ☒ Transformer KVA Report
 - ☒ Pole Treatment Report
 - ☒ Pole Joint Use Report
 - ☒ Copy of (Service Location Details Report)
 - ☒ Transformer Load
 - ☒ Service Location Count Report
 - ☒ CPR Report

Feeder Select

- ☐ Asheboro-East
- ☐ Bear Creek
- ☐ Dover
- ☐ Eastwood
- ☐ Eastwood 25kV
- ☐ Five Points
- ☐ Grays Chapel
- ☐ Liberty Hill
- ☐ Love Joy
- ☐ Robbins
- ☒ Snow Camp
 - ☒ FD. 2
 - ☒ FD. 3
 - ☒ FD. 1
 - ☒ FD. 4
- ☐ Spero
- ☐ Staley
- ☐ Ulah
- ☐ Wall

Display Source

Cancel Solve

Origin Query Report

RESULTS

Parent Class	FACILITYID
Feeder	01

OVERHEAD

FEATURES>

Line Type	PhaseCode
UNDERGROUND	

FEATURES>

Line Type	PhaseCode
OVERHEAD AND UNDERGROUND	

-->Total Miles of PrimaryLine (64.41)
 -->Total Feet Of PrimaryLine (340097.33)

OVERHEAD AND UNDERGROUND

-->Total Miles of SecondaryLine (35.02)
 -->Total Feet Of SecondaryLine (184931.55)

RESULTS

Parent Class	FACILITYID
Feeder	02

OVERHEAD

FEATURES>

Line Type	PhaseCode
UNDERGROUND	

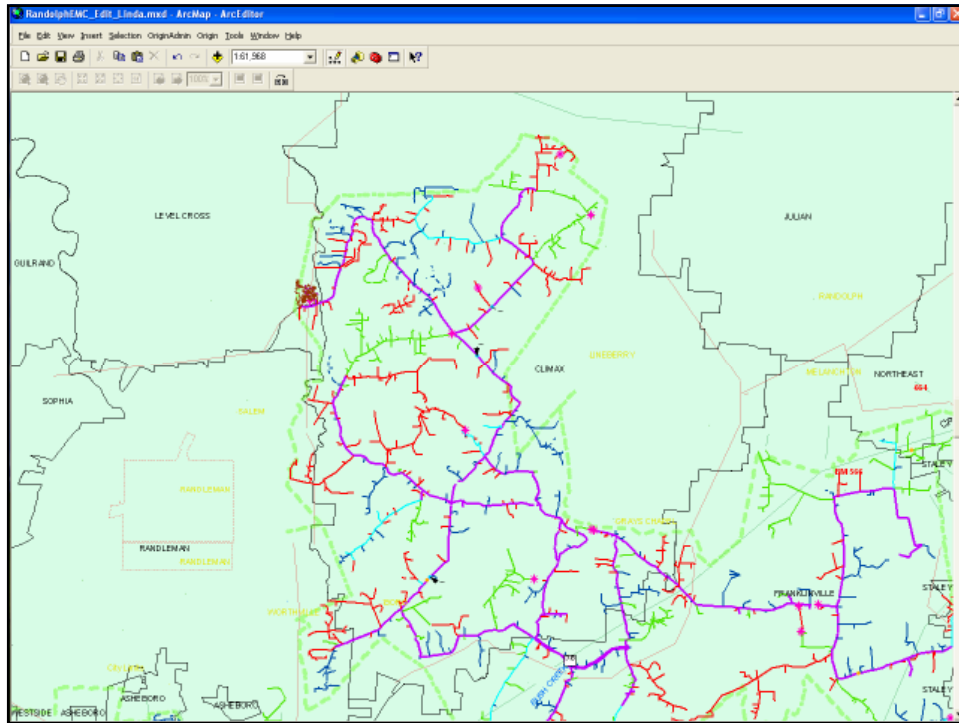
FEATURES>

Line Type	PhaseCode
OVERHEAD AND UNDERGROUND	

-->Total Miles of PrimaryLine (62.21)
 -->Total Feet Of PrimaryLine (328458.41)

OVERHEAD AND UNDERGROUND

-->Total Miles of SecondaryLine (27.02)
 -->Total Feet Of SecondaryLine (142686.49)

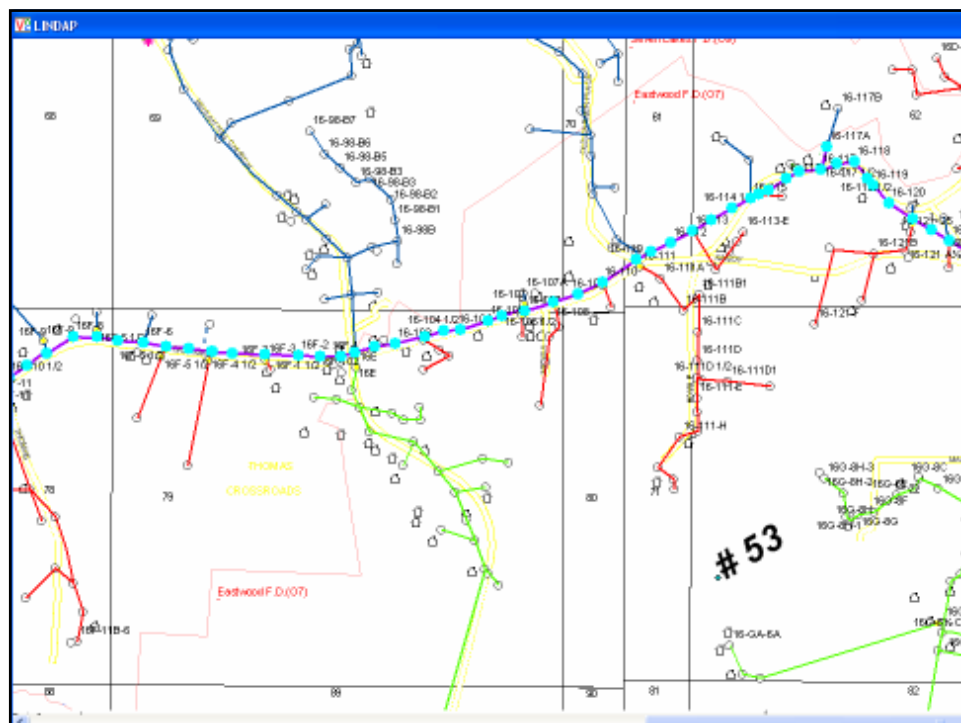


Origin Query Report

Feeder Distance Report (by Fire District) Query

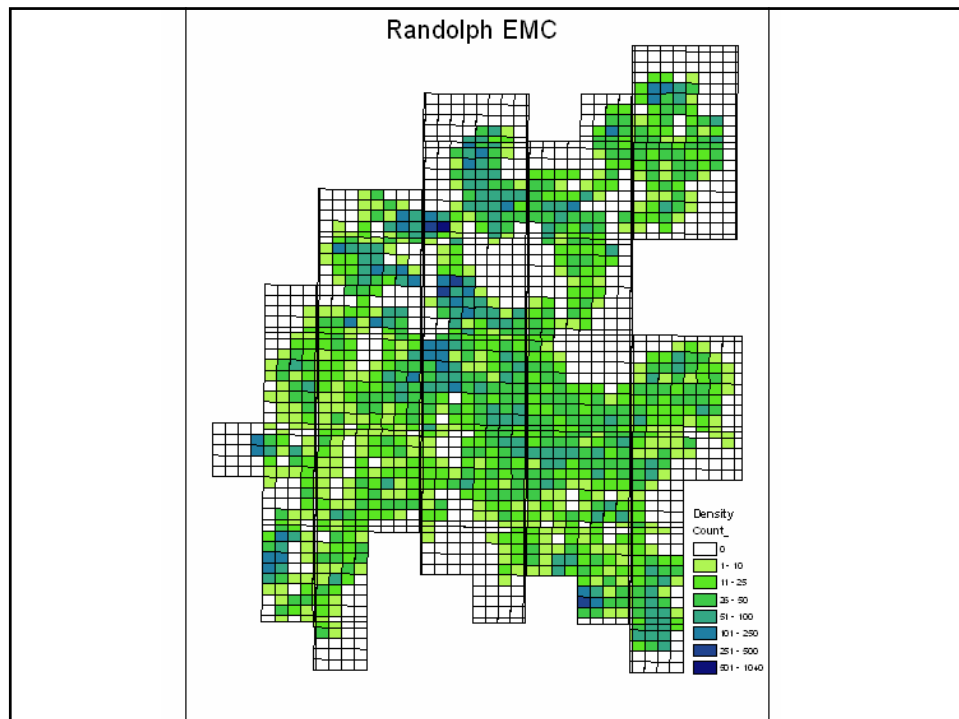
RESULTS

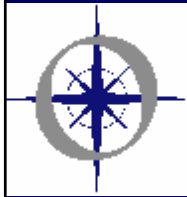
PARENT CLASS	FIRE_NAME	OBJECTID		
Randolph_firedist	CLIMAX	66		
OVERVIEW BASED OFF LINE TYPE	FEET OF LINE	MILES OF LINE		
PrimaryLine	594174.72	112.53		
SecondaryLine	363332.92	68.81		
OVERVIEW BASED OFF PLACEMENT	FEET OF LINE	MILES OF LINE	PLACEMENT	
PrimaryLine	564933.72	107.00	0	
PrimaryLine	29241.00	5.54	1	
SecondaryLine	294587.79	55.79	0	
SecondaryLine	68745.13	13.02	1	
DETAILED LISTING BY LINETYPE	PHASE CODE	PLACEMENT	FEET OF LINE	MILES OF LINE
PrimaryLine	A	OverHead	192217.00	36.40
PrimaryLine	AB	OverHead	1450.83	0.27
PrimaryLine	ABC	OverHead	146803.60	27.80
PrimaryLine	AC	OverHead	20980.07	3.97
PrimaryLine	B	OverHead	102620.32	19.44
PrimaryLine	BC	OverHead	1131.38	0.21
PrimaryLine	C	OverHead	99730.52	18.89
PrimaryLine	A	UnderGround	8703.71	1.65
PrimaryLine	ABC	UnderGround	5468.49	1.04
PrimaryLine	B	UnderGround	414.88	0.08
PrimaryLine	C	UnderGround	14653.92	2.78
SecondaryLine	A	OverHead	130113.62	24.64
SecondaryLine	AB	OverHead	174.78	0.03
SecondaryLine	ABC	OverHead	1913.88	0.36
SecondaryLine	AC	OverHead	1548.45	0.29
SecondaryLine	B	OverHead	76843.67	14.55
SecondaryLine	C	OverHead	83993.39	15.91
SecondaryLine	A	UnderGround	26492.58	5.02
SecondaryLine	ABC	UnderGround	1876.94	0.36
SecondaryLine	AC	UnderGround	160.00	0.03
SecondaryLine	B	UnderGround	15046.11	2.85
SecondaryLine	C	UnderGround	25169.50	4.77



Pole Distance from Source

<i>FACILITYID</i>	<i>Distance</i>	<i>Pole Number</i>
3473072	0.15	16-140
3473074	0.2	16-139½
3473075	0.26	16-139
3473076	0.31	16-138½
3473069	0.38	16-138
3473003	0.44	16-137
3473024	0.47	16-136
3473029	0.56	16-135
3473049	0.63	16-134
3473068	0.68	16-133





Benefits of GIS

■ Integration with CIS

- Made decision to run batch process to update GIS with CIS data until new CIS installed

Attributes

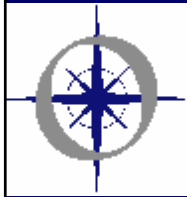
ServiceLocation

- + 2144054
- + 2144027
- + 2144002
- + 2144046
- + 2144007
- + 2144031
- + 2144017
- + 2144004
- + 2144013
- + 2144057
- + 2144060
- + 2144041
- + 2144061
- + TransformerBank
- + OriginGIS.GISADMIN.Pole
- + PrimaryLine
- + SecondaryLine
- + Transformer

73 features

Attributes | Station | Comments | **Other** | CisMeters | CisUsage

KVA:	0010
NAME:	JOHNSON ROBERT
ADDRESS1:	5124 BENT RIDGE RD
ADDRESS2:	
INCAREOF:	
CITY:	SEAGROVE
COUNTY:	RA
METERNUM:	47703
CYCLE:	410
BOOK:	72000
SEQUENCE:	45600
STATUS:	A
LOC2000:	5136 BENT RIDGE RD
.....	-

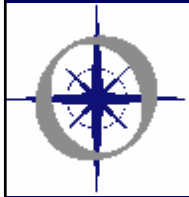


Benefits of GIS

- Integration with Automated Staking
 - Application-level integration
 - Live access to Partner Hub from GIS
 - Find jobs, view staking sheets
 - Build GIS database & model on import
 - Creates historical work order database
 - Stores job header and PDF staking sheet

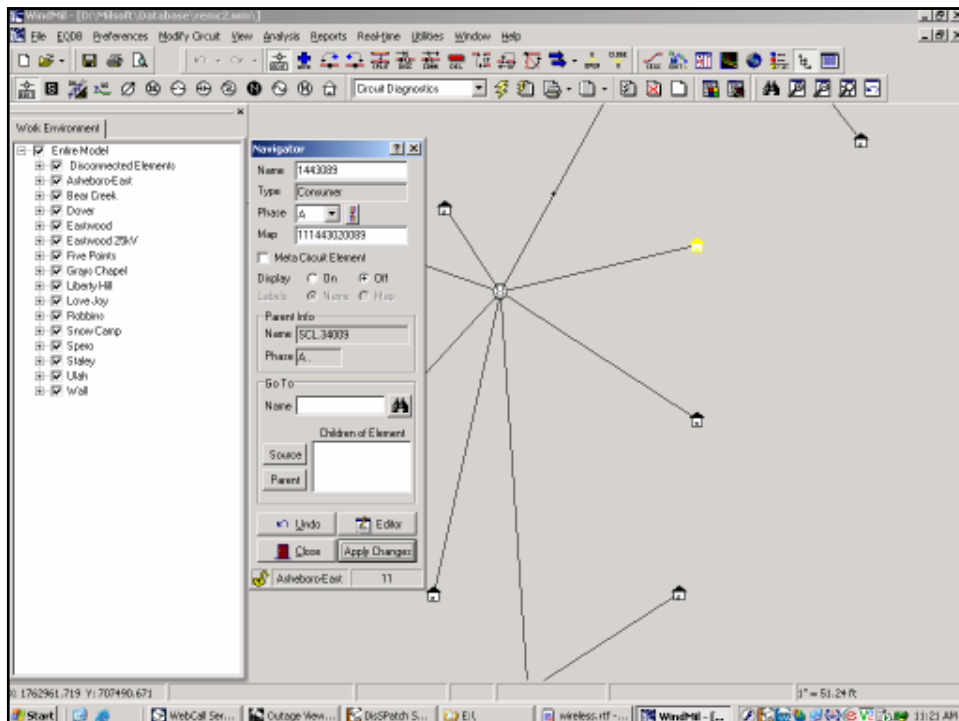
The screenshot displays the ArcGIS Desktop environment. The main map window shows a city map with various colored lines representing utility networks. A 'Partner Staking Import' dialog box is open, showing a table of job data. The table has columns for Job Number, Job Name, Job Number, and Staker. The data includes jobs like 'Kenny Street', 'REMCO CIPS 7267', 'CIR 48 VANDER O...', 'RICHARD J. LORE...', 'REMCO', 'REMCO', 'REMCO', 'CHRISTINA WAE...', and 'ARTHUR D. WILS...'. The interface also shows a 'Map' window with a legend and a 'Table of Contents' window.

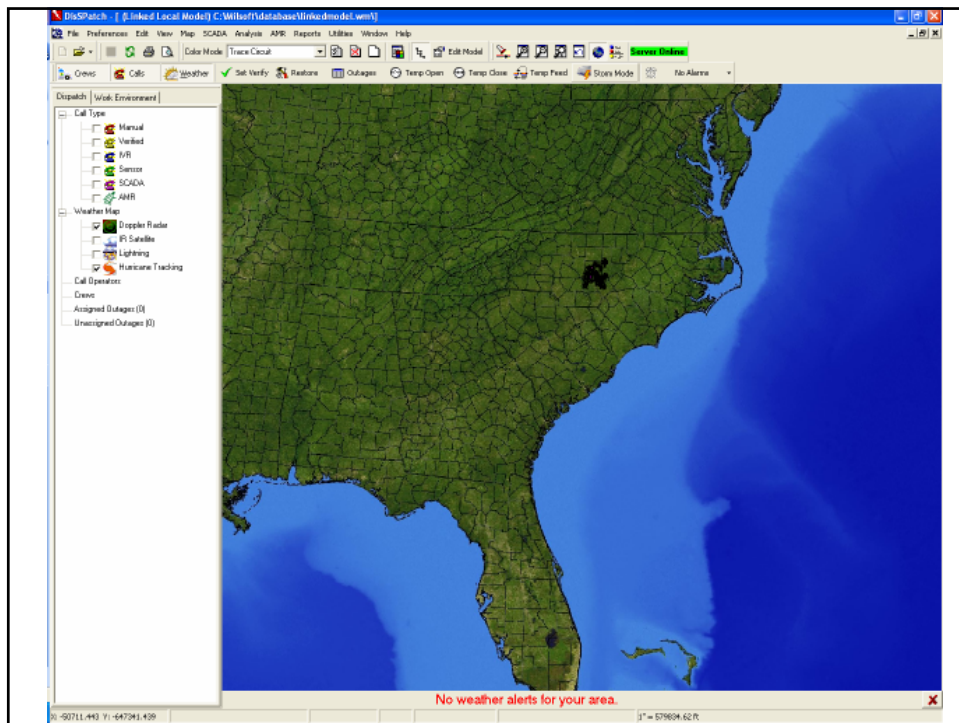
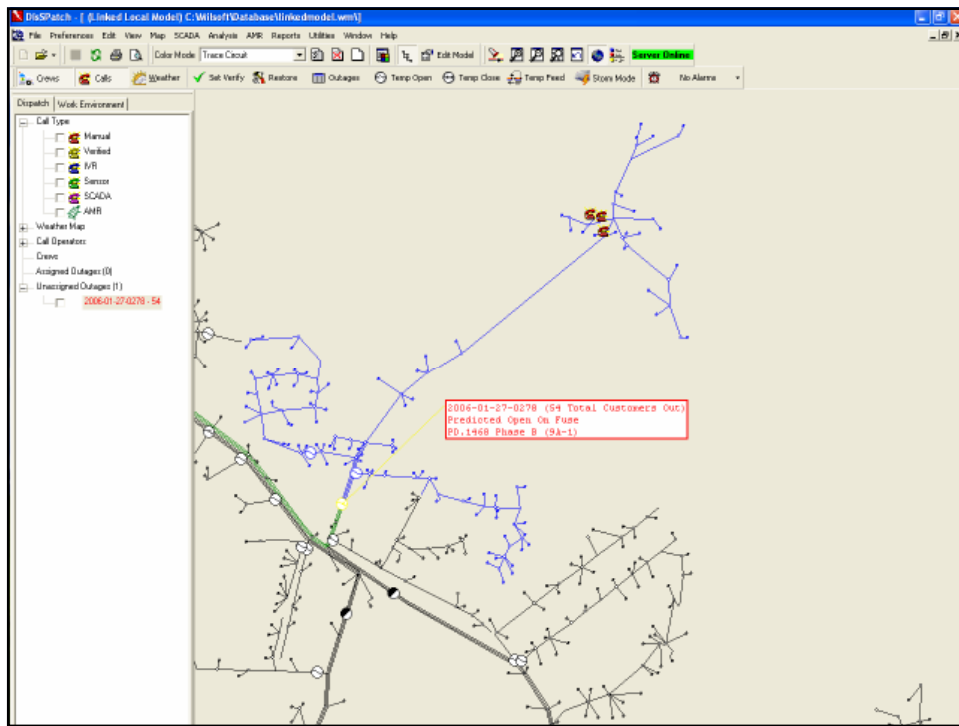
Job Number	Job Name	Job Number	Staker
0100	Kenny Street	05014	Doyle-Monaco
2090	REMCO CIPS 7267	WLB071	Doyle-Monaco
2013	CIR 48 VANDER O...	JDM1000	Doyle-Monaco
4055	RICHARD J. LORE...	JDM1134	Doyle-Monaco
83014	REMCO	JDM1006	Doyle-Monaco
2014	REMCO	JDM1013	Doyle-Monaco
0014	WENDY JO BEND...	JDM1012	Doyle-Monaco
0024	CHRISTINA WAE...	JDM1014	Doyle-Monaco
0034	ARTHUR D. WILS...	JDM1016	Doyle-Monaco

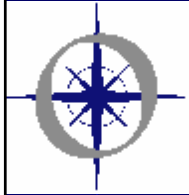


Benefits of GIS

- Integration with Engineering Analysis and Outage Management
 - Milsoft's WindMil and DisSpach
 - Origin provides translation map table to map fields for preferred nomenclature
 - Display load flow and short circuit analysis results

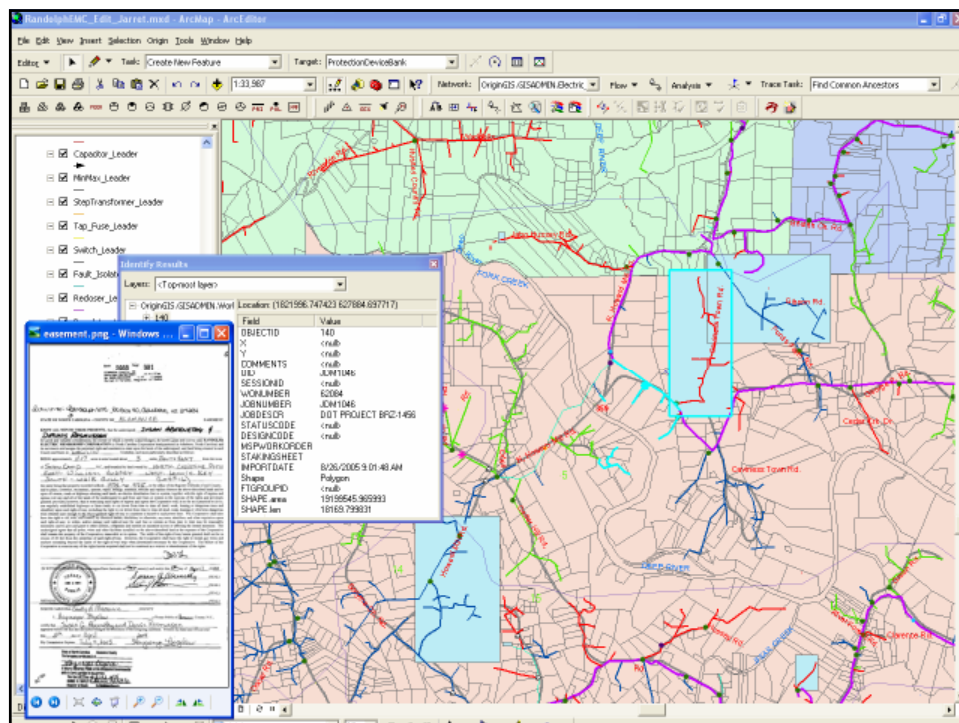






Future goals for GIS at Randolph EMC

- Easement integration
- Add Transmission to the network
- Enhance queries and reports
- Seamless integration with new CIS
- Seamless integration with Register of Deeds



Questions?



**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

**Overview of the
Broadband Loan Program**

**Cecile Shaya
Senior Loan Specialist
Southern Operation Branch
Broadband Division
Telecommunications Program**

BIOGRAPHICAL SKETCH

Cecile Shaya

Ms. Shaya is a Senior Loan Specialist for the Rural Development, Utilities Program, Broadband Division. She has over 10 years of financial and lending experience. She received her MBA from Columbia Business School in Corporate Finance and Operations Management. Afterwards, she worked for the CIT Group; a multi-billion dollar asset based lending company. Then, she worked for the U.S. Small Business Administration central office in Washington DC in various lending programs and in the office of Liquidation and Loan Restructuring.



Rural Broadband Access Loan and Loan Guarantee Program

Rural Development
1400 Independence Ave.
Washington, DC 20250
www.usda.gov/rus/

Presenter:
Cecile Shaya



Broadband Grants... *Community Connect*

What is Community Connect?

A nationally competitive grant program to provide broadband service on a "community-oriented connectivity" basis to:

*The most rural and
economically challenged communities.*



Rural Broadband Loan and Loan Guarantee

2



Broadband Grants... *Community Connect*

Eligible Applicant:

- Incorporated organization
- Limited Liability Company
- Indian Tribe or Tribal organization
- State or Local unit of government
- Cooperatives



Rural Broadband Loan and Loan Guarantee

3



Broadband Grants... *Community Connect*

Eligibility Requirements:

- No existing broadband service.
- Small community recognized by the census (pop. < 20,000).
- Free broadband service to critical facilities.
 - Schools, libraries, educational centers, healthcare providers, law enforcement agencies, and public safety organizations.



Rural Broadband Loan and Loan Guarantee

4



Broadband Grants... *Community Connect*

Eligibility Requirements:

- Offer residential and business service.
- Provide a community center for 2 years with at least 10 computer access points.



Rural Broadband Loan and Loan Guarantee

5



Broadband Grants... *Community Connect*

Community Connect Grant Program:

- *Application window to be announced...*
- *Visit the web for more information:*

www.usda.gov/rus/telecom/commconnect.htm



Rural Broadband Loan and Loan Guarantee

6

Purpose of the Broadband Loan Program

To provide loans for the cost of construction, improvement, and acquisition of facilities and equipment for broadband services in eligible rural communities.



Rural Broadband Loan and Loan Guarantee

7

Broadband Loan Program: FY2006 Budget

- @ 4% Funding: \$64 Million is available
- @ Treasury Rate Funding: \$1.085 Billion



Rural Broadband Loan and Loan Guarantee

8

Program Statistics

156 Applications Received in 3 years,
requesting \$2,326,000,000

Applications Processed as of January 17, 2006

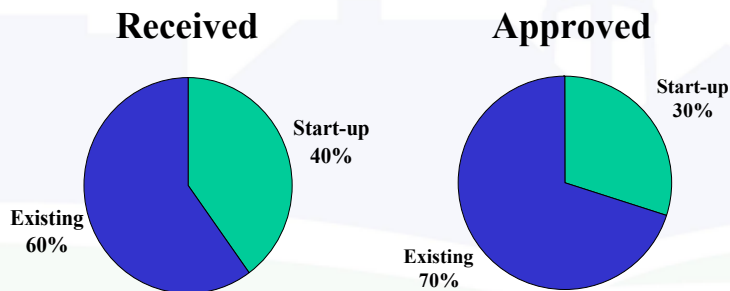
52 Approved	\$824,000,000
8 In Review	\$162,000,000
96 Returned	\$1,340,000,000



Rural Broadband Loan and Loan Guarantee

9

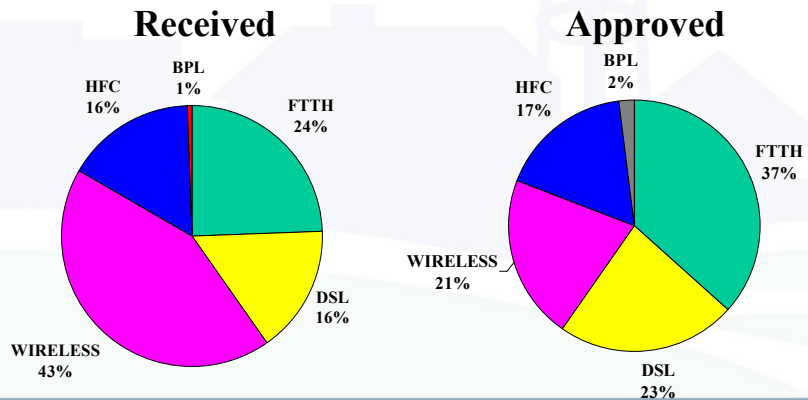
Program Statistics – Type of Entity



Rural Broadband Loan and Loan Guarantee

10

Program Statistics – Technologies



Program Statistics – Why some are returned!

- Insufficient credit support
- Insufficient market survey
- Technology does not meet requirements
- Cannot meet minimum financial requirements
- Incomplete application

Eligible Rural Community

Eligible rural community means any incorporated or unincorporated place in the United States, its territories and insular possessions (including any area within the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau) that has no more than 20,000 inhabitants, based on the most recent available population statistics from the Bureau of the Census – <http://www.census.gov>

Broadband Service

- Must enable a subscriber to transmit and receive at > 200 Kb/s; and
- Must provide data transmission service and may provide voice, graphics, and video.

Applicant Eligibility

A legally organized entity providing or proposing to provide service to an eligible rural community that has sufficient authority to enter into a contract with Rural Development, Utilities Programs (RDUP), and can carry out the purposes of the loan.

Who is not Eligible?

- Individuals
- Partnerships (including LLPs)
- Any entity serving more than 2% of the telephone subscriber lines installed in the United States

Eligible Purposes

- New construction and improvements to existing facilities.
- Broadband facilities leased under the terms of a capital lease (limited to 5 years and option of ownership)
- Acquisitions of Assets (less than 50% of the requested loan amount)
- Refinancing existing Telecommunications Program debt (up to 40% of requested loan amount)

Ineligible Purposes (1)

- Acquire stock, facilities, or equipment of an affiliate of the applicant.
- Finance customer terminal equipment (including modems) or inside wiring not owned by the applicant.
- Purchase vehicles that are not used primarily in construction

Ineligible Purposes (2)

- Broadband facilities leased under an operating lease:
 - *e.g.*, tower leases, building leases, land leases.
- Operating expenses
 - *e.g.*, salaries, marketing, legal.
- Mergers or consolidations

Types of Loans

- Direct Cost-of-Money Loans
- Direct 4% Loans
- Private Lender Guarantees

Direct Cost-of-Money Loans

Bear interest at the cost of money to the Treasury for comparable maturities.

The interest rate is set at the time of each advance of funds

The current rates can be found at:

<http://www.federalreserve.gov/releases/h15/update>

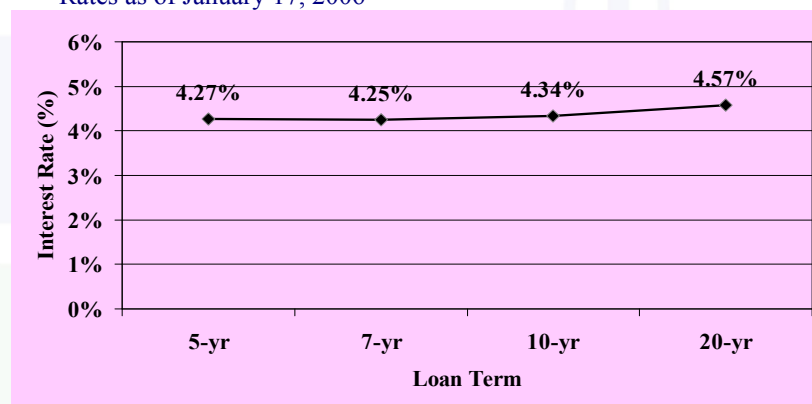


Rural Broadband Loan and Loan Guarantee

21

Direct Cost-of-Money Rates

Rates as of January 17, 2006



Rural Broadband Loan and Loan Guarantee

22

Direct 4% Loans

- To be eligible for this loan, the applicant must be proposing to serve a community that:
 - Does not have any broadband service;
 - Has a population of 2,500 or less;
 - Located in a county with a per capita personal income that is less than or equal to 65% of the national per capita income; and
 - Has a service area with a maximum population density of 20 persons per square mile.

Direct 4% Loans

- Loan Amount is limited to \$7.5 million
- Can be made simultaneously with Direct Cost-of-Money loans

Loan Guarantees

- This bears interest at a rate set by the lender;
 - The interest rate must be fixed, and the same for the guaranteed and un-guaranteed portion of the loan.
- Government guarantee is made for no more than 80 percent of the amount of principal

Loan Terms (1)

- Loans are made for a term equal to the expected useful service life of the facilities financed.
- Funds are advanced as needed.
- Interest is payable monthly on funds advanced.
- Principal payments are deferred for 1 year from the date of the first advance

Loan Terms (2)

- The minimum amount of a loan that RDUP will consider is \$100,000
- Maximum loan amounts apply only to the direct 4% loans (\$7.5 Million)
- The minimum TIER is 1.25 at the end of the 5th year of the feasibility study

Loan Terms

TIER means Times Interest Earned Ratio.

$$\text{TIER} = \frac{\text{Net Income} + \text{Interest Expense}}{\text{Interest Expense}}$$

For the purpose of this calculation, all amounts will be annual figures and interest expense will include only interest on debt with a maturity greater than one year.

Loan Terms

- Rural Development generally requires a first lien on the borrower's assets
 - Will share the first lien position (pari passu) with another lender on a pro rata basis
 - Will develop security arrangements if bond financing is involved in the project

Application Information

The regulation, application, application guide, and all other relevant information including the latest approved and pending community list is available on our website at:

www.usda.gov/rus/telecom/broadband.htm

Application Submission

- Prospective applicants should contact their respective General Field Representative (GFR) prior to submitting the application
 - List of the GFRs and the contact information is included in Application Guide
- There is no deadline to submit applications
- Applications will be reviewed and processed on a first-come, first-served basis

Key Components of an Application

- Credit Support
 - Business Plan
 - Market Survey
 - Financial Information
 - System Design

Credit Support

**THE NUMBER ONE REASON
APPLICATIONS ARE
RETURNED!**

Credit Support

7 CFR 1738.20

- Minimum of 20% of the requested loan amount, including:
 - Cash for one full year operating expense, and
 - Net plant, cash, or letter of credit.

Cash Requirement

- Defined as sufficient cash to cover one full year of operating expenses; but
 - For telecommunication companies with positive cash flow for the two previous years, this requirement can be waived.

CONTACT INFORMATION

Kenneth Kuchno -
Director, Broadband Division

kenneth.kuchno@wdc.usda.gov

202.690.4673

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

**Aging Conductor and Equipment
Analysis and Recommendations**

**Bob Dew, PE, CEO
Power Tech Engineering, LLC**

BIOGRAPHICAL SKETCH

Bob Dew

Bob Dew is currently CEO of PowerTech Engineering LLC and has been since January 2002.

Bob began his career in 1972 as the System Engineer for Harrison County REMC in southern Indiana. He later became the system engineer at Tipmont REMC in Linden, Indiana. After that, Bob spent 26 years with Southern Engineering Company in Atlanta, Georgia, where he was Vice President of Engineering for 13 years. Bob's specialties are distribution systems engineering and planning, territorial affairs, Electrical Accident Investigations, NESC applications/interpretations and golf. Bob has practiced engineering in his 34-year career from Alaska to the West Indies.

After leaving Southern, Bob became the Executive Vice President and COO of United Utility Supply in Louisville, Kentucky, for 2 years before joining PowerTech Engineering.

Bob has a BSEE degree from Purdue University, took post-graduate courses in Electrical Engineering at Georgia Tech, and has an MBA from Butler University in Indianapolis. Bob is a licensed Professional Engineer in 20 states.

Aging Conductor & Equipment

Analysis & Recommendations



RUS
2006 Electric Engineering Seminar

February 15, 2006
ORLANDO, FLORIDA

Presenter



Robert C. Dew, Jr., P.E.
CEO
PowerTech Engineering, LLC
Tucker (Atlanta), Georgia

770-209-9119
bdew@pt-eng.com

Contents



1. Introduction
2. Statement of the problem(s)
3. Solutions to the problem(s)
4. Record Keeping Requirements (NEW)
5. Maintenance Schedules
6. Inspection Provisions
7. Recommendations

Slide # 3

Problem



Part of your system is growing at a fast pace (>5% per year) -- ie, the suburban or urban part or along the interstate.

And part of your system is old and growing very slowly, if at all -- ie, the rural areas.

Slide # 4

What do you do?



Spend all funds on the growing part and
don't spend any money on the other part
until it falls down?

Don't spend any money at all ?
(are you an accountant?)

Slide # 5

What do you do?



Nothing?

Absolutely NOT!

Try to balance your expenditures across all
of your system to maintain a high degree of
reliable service and improve bad areas.

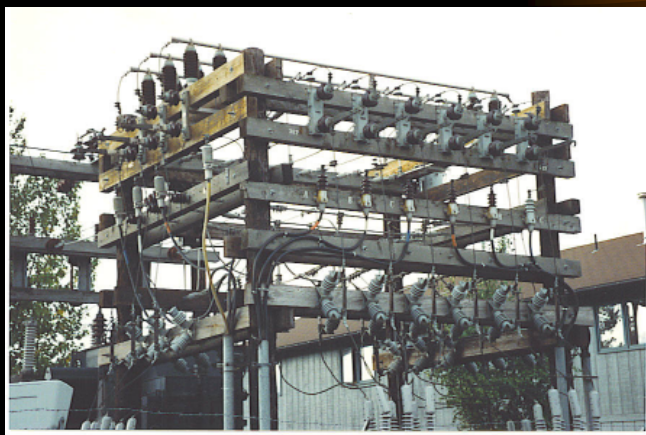
Slide # 6

The “Problem” (some of them)

- Old Poles
- Old & Obsolete Conductors (copperweld & aluminum)
 - Excessively long spans & aging conductors
- Bad right-of-way (extreme tree growth)
- Old & Obsolete Substations
- Old & Obsolete Substation Transformers
- Old Transmission Lines (34.5 kV, 46 kV)
- Old Recloser & Old Switches
- Old Voltage Regulators

Slide # 7

Wooden Substation



Slide # 8

Overloaded Substation



Slide # 9

Antique Substation – 1930's



Slide # 10

Antique Substation



Slide # 11

The “Problem” (some of them)

- Excessive outages on parts of the system
- Excessive animal-caused outages
- Excessive losses
- Inadequate budget
- PCB transformers
- Old concentric neutral underground
- Impending Liability

Slide # 12

The “Problem” (some of them)

- Inadequate sectionalizing and overcurrent protection
- Inadequate system detail maps
- Old knife blade switches
- Old reclosers
- Old ABS out of adjustment
- Insufficient grounding

Slide # 13

The “Problem” (some of them)

- Rusting equipment
- High voltage complaints
- Low voltage complaints
- No easement documentation
- Inadequate patrolling of lines
- Inadequate inspection of lines

Slide # 14

The “Problem” (some of them)

- Lack of records by specific areas or by specific districts
- Current records are probably system-wide or averages
- Some records exist by substation, but usually not enough

Slide # 15

The “Problem” (some of them)

- Antique SCADA system
- Antique two-way radios
- Antique microwave systems

Slide # 16

The “Problem” (some of them)

Keep in mind that most of rural America was electrified from 1945 to 1952 during the Truman Administration and a LOT of original line is still in the air.

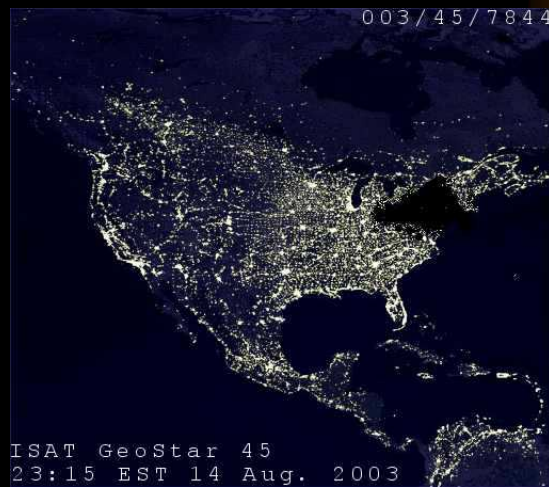
Slide # 17

Record Keeping Requirements (NEW)

- Do you currently keep outage records by substation, by circuit, by section — or by individual consumer?
- If not, start keeping them at least by substation and by circuit.
- Identify and quantify problems on a much smaller scale such as substation area than system-wide.

Slide # 18

Satellite Photo of Power Outage



Slide # 19

What Is Your Outage Criteria?

2 days / consumer per year?
5 hours / consumer per year?
1 hour / consumer per year?
Other?

Do you have different outage criteria for different parts of your system? Urban vs Suburban vs Rural?

Slide # 20

System Losses



- Do you currently keep system losses by substation on a monthly and yearly basis?
- Start keeping records on a much smaller scale (ie, by substation area) so you can identify problems in different parts of the system.

Slide # 21

System Losses



kWH losses are a costly part of System Operation.

They also present an opportunity to improve losses and reduce overall costs.

Slide # 22

Typical Systems



44,000 Consumers

kWH Purchased = 1,004,892,872

kWH Sold = 942,662,979

kWH Losses = 62,229,893 \Rightarrow 6.19%

Total Electric Revenue = \$64,148,728

Slide # 23

Typical Systems



Cost of kWH Purchases = $\frac{\$46,804,256}{1,004,892,872}$ = 4.658 ¢ / kWH

Cost of Losses = (62,229,893) (4.658 ¢ / kWH) = \$2,898,442

If you can lower losses 1%, you save \$468,246 !

Slide # 24

System Losses



One way to determine if you have excessive losses from your transformers is to compare installed transformer capacity to System Demand.

$$\frac{\text{Total Transformer Capacity (kVA)}}{\text{System Peak Demand (kW) / p.f.}} = \text{Over Capacity Factor}$$

If “Over Capacity Factor” is excessive (i.e., approaches 2.0), you are contributing to your losses!

Slide # 25

Underground Cable



- Do you have any High Molecular Weight (HMW) cable left? If so, replace it now!
- Have you identified all the areas where you have bare concentric neutral cable still installed? Non-tree retardant cable installed? What is the age of these respective cable installations?
- Have you quantified the replacement costs?
- Do you have a timeframe for replacement?

Slide # 26

Underground Cable



Slide # 27

Underground Cable



Slide # 28

Old Transformers



- Do you have any old 1.5 kVA, 3 kVA, 5 kVA, or possibly any 7.5 kVA transformers left? Check your CPR or mapping records.
- Do you have any PCB transformers or capacitors or substation transformers left?
- Put these on the list for possible replacement / retirement after checking the KWH usage, etc.

Slide # 29

Right-Of-Way



1. How many miles of right-of-way (ROW) do you have on your system that need to be cleared periodically?
2. Is the ROW in worse condition in the slow-growth areas?
3. How many miles did you clear, cut or mow last year?
4. How many years will it take, based upon past performance, to get over your system?

Slide # 30

Right-Of-Way ?



Slide # 31

Right-Of-Way

5. Since trees and bushes grow at different rates, what do you think your optimum cycle is?

5 years?
7 years?
10 years?
Longer?

Slide # 32

Recloser Maintenance

1. How many 1-phase oil circuit reclosers do you have on your system at present?
2. Do you check the operations counters on these devices from time to time? Do you maintain these devices?
3. Do you have a formalized maintenance plan, or is it the "Mother Nature Maintenance" Plan (as in, when it blows off the pole, you replace it with a new one)?
4. When is the last time you had a complete sectionalizing study performed by a consulting engineer or in-house?
5. One problem is that over time the available fault current exceeds the reclosers rating.

Slide # 33

1-Phase, Recloser Ratings

Recloser Size & Type	Interrupting Rating (Amps)	Operations before Recommended Maintenance
25H	625	100
35H	875	100
50H	1,250	100
25-4H	1,000	68
35-4H	1,400	68

Slide # 34

Recloser / Breaker Maintenance

When have you tested / calibrated your electro-mechanical relays? 1 year? 5 years? Ever?

CO-9, CO-8, IAC-53s?

Do you have plans to replace them?

Still have any Cooper/McGraw Edison Form 3A controls?

What about the contacts in the oil insulated units?

Slide # 35

Voltage Regulators

1. Do you check the operations counter monthly?
2. Has the number of operations exceeded manufacturers recommendations, typically 20 years or 1,000,000 operations (see manufacturers recommendations)?
3. Can the regulator stand the available fault current if a fault occurs? In general, this is 40 times the nameplate ampere rating of the regulator for a time period of 0.8 seconds.

Slide # 36

Pad Mounted Equipment

Transformers & Switchgear



1. Structural problems are the predominant failure mode.
2. Rust and corrosion are this type of equipment's biggest enemy.
3. Oil leaks can also occur.
4. Routine visual inspection is required (see CRN Report #98-11).

Slide # 37

Aging Conductors



Given the fact that Overhead Power Conductors have an average life span expectancy of 50-to-70 years, it is clear that many (if not all) of the original distribution lines have reached, will reach, or are beyond their useful life span.

See CRN Report #00-31

Slide # 38

Commonly Used Original Conductors

Size	Type	Approx Capacity	Rated Breaking Load (lbs) NEW Conductor	Weight (lbs/mile)
2A	Copperweld-Copper	240	5,876	1,356
4A	Copperweld-Copper	180	3,398	853
6A	Copperweld-Cooper	140	2,585	536
8A	Copperweld-Copper	100	2,233	392
9-1/2 D	Copperweld-Copper	65	1,743	298
3 #12	Copperweld	90	2,236	289
4	ACSR 7/1	140	2,288	356
2	ACSR 7/1	180	3,525	566
1/0	ACSR	230	4,280	769

Slide # 39

Why Conductors Fail

- Ice loading exceeds “maximum conductor tension”
- Long spans with ice loading
- Arcing damage (trees, lightning, wind, etc)
- Surface corrosion on copperweld conductors
- Electrolytic corrosion due to galvanic action

Slide # 40

Why Conductors Fail



- Surface corrosion and inner corrosion on aluminum conductors
- Loss of zinc coating on steel core wires (ACSR conductors)
- Fatigue failure due to wind-induced vibration
- Annealing due to excessive electrical current (hard drawn copper wire)

Slide # 41

Record Keeping On Conductors



Keep detailed outage records when conductor failure is the cause.

A database needs to be built and maintained detailing conductor failure.

Slide # 42

Inspection Provisions



The inspection provisions are contained in the 2002 NESC, Section 214, Page 60 as follows:

A. When In Service:

1. Initial Compliance with Rules: lines and equipment shall comply with these safety rules when placed in service.
2. Inspection: lines and equipment shall be inspected at such intervals as experience has shown to be necessary.
NOTE: It is recognized that inspections may be performed in a separate operation or while performing other duties, as desired.

Slide # 43

Inspection Provisions



A. When In Service (continued):

3. Tests: when considered necessary, lines and equipment shall be subjected to practical tests to determine required maintenance.
4. Record Of Defects: any defects affecting compliance with this code revealed by inspection or tests, if not promptly corrected, shall be recorded; such records shall be maintained until the defects are corrected.
5. Remedying Defects: lines and equipment with recorded defects that could reasonably be expected to endanger life or property shall be promptly repaired, disconnected or isolated.

Slide # 44

Inspection Provisions

B. When In Service (continued):

1. Lines Infrequently Used: lines and equipment infrequently used shall be inspected or tested as necessary before being placed into service.
2. Lines Temporarily Out Of Service: lines and equipment temporarily out of service shall be maintained in a safe condition.
3. Lines Permanently Abandoned: lines and equipment permanently abandoned shall be removed or maintained in a safe condition.

Slide # 45

Line Inspection ?



Slide # 46

Deer Problems



Slide # 47

Deer Problems



Slide # 48

CATV – Inspection!



Slide # 49

Wood Pole with CATV Attachment



Slide # 50

Line By Apartment Bldg Horizontal Clearance ?



Slide # 51

Line Inspection



Slide # 52

Underground Utility Inspection



Slide # 53

RUS Bulletin 1730-1

Electric System Operation & Maintenance (O&M) says
in Section 3—Distribution Lines, Overhead (pg.8)

“... All overhead lines (including those on private right-of-way)
patrolled annually (walking, riding or aerial); more frequently
if experience dictates.”

Slide # 54

Webster's Collegiate Dictionary

The 9th Edition says:

Inspect:

1. To view closely in critical appraisal: look over
2. To examine officially

Patrol:

- a. The action of traversing a district or beat or of going the rounds along a chain of guards for observation or the maintenance of security
- b. The person performing such an action

Slide # 55

Line Patrol Plane



Slide # 56

Line Inspection ?



Slide # 57

Line Patrol ?



Slide # 58

Line Patrol & Inspection ?



Slide # 59

Line Inspection / Patrol



Slide # 60

Voltage Drop

- Does part of your system suffer from excessive voltage drop at peak times? This is another symptom of small conductor and long feeders.
- Keep in mind that the original REA designs used 40- to 60-kWH per consumer per month as their design criteria.
- The following are some of the constraints of small original conductor.

Slide # 61

Voltage Drop Table

Maximum Ampacity	Conductor	R+ ; x*	Single Phase
			Voltage Drop Factor @ 7.2 kV
?	#6 Steel	Who Cares?	Too Much!
90 A	3 #12	7.62+ j1.71	19.6
85	9-1/5 D	5.15+ j1.61	13.6
100	#8 A	3.72+ j1.54	10.3
140 A	# 6 CU	2.47+ j1.46	7.36
180 A	# 4 CU	1.64+ j1.47	5.45

* Ohms per phase per mile of line

Slide # 62

Voltage Drop Calculation

$$VD = \text{Voltage Drop} = \frac{(kW)(s)(VDF)}{1000}$$

= voltage drop on 120V base at 90% power factor

EXAMPLE:

$$VD = (300 \text{ kW})(5)(10.3) / 1000 = 15.45 \text{ V}$$

300 kW at the end of 5 miles

1-phase, 8A conductor

Slide # 63

Model Discrepancies

1. Line sections are of wrong distance.
Database build error.
2. Mixed conductor spans wind up on the database as largest conductor (ie, 1 #6, 1 #8, 1 #4, with an 8A neutral is listed in the model as 3-phase, 4CU)
3. Regulators and capacitors listed in wrong place electrically.

Slide # 64

The “Solution”



Review your “Mission Statement”

1. Keep the lights on as much of the time as possible (ie, during the Super Bowl, soap operas, cooperative board meetings, cooperative annual meetings, presidential debates, election coverage).

Slide # 65

The “Solution” (continued)



2. Quantify the problem by making a list of all known system deficiencies in the slow-growth area.
3. Estimate cost to repair / replace each item based upon current costs.

Slide # 66

The “Solution” (continued)

4. Prioritize the list based upon one or more of the following subjective criteria using good engineering judgment:
 - a) Cost benefit ratio
 - b) Outage reduction
 - c) Improved losses
 - d) Reduced liability
 - e) Improved operational flexibility
 - f) Improved safety

Slide # 67

The “Solution” (continued)

Examine with your current work plan:

- Quantify proposed investment in slow-growth areas.
- Examine Form 7 (year-end) and completed work orders; determine how much investment in slow-growth areas was added to plant over last year.
- Compare these two numbers to see how “big” the problem is. If the amount spent in low-growth areas last year is zero (\$0.00) or essentially zero, you have a huge problem.

Slide # 68

The “Solution” (continued)

How many poles do you have on your system?

- Roughly 20 poles/mile x miles of line = number of poles on the system.
- Review your CPR records of poles. How do they compare?
- How many poles did you inspect last year?

Slide # 69

The “Solution” (continued)

- What is the average age of the poles on your system? By substation? By geographic area? Don't know? You need to find out!
- How many years will it take to get over your system at last year's inspection rate?
5 years? 10 years? 20 years? Never?
- Is the above timeframe acceptable?

Slide # 70

The “Solution” (continued)



- How many poles did you replace last year?
- How many did you inspect and treat with a ground line treatment if needed?
- Determine cost/benefit or payback period on treating poles.

Slide # 71

The “Solution” (continued)



- How many miles of copper/copperweld line do you have left? Check both your CPR records and your engineering model. Most copper line is at least 50 years old!
- Remove steel lines immediately!

Slide # 72

The “Solution” (continued)

- Do you have a plan for removing the copper/copperweld line? What is it? Has the Manager/CEO approved it? What about the Board? Time frame? 5 years? 10 years? Longer?
- Put a portion in each “Work Plan” and follow through on removing it. My recommendation is to replace all small 1-phase or V-phase copper distribution lines within the next 10 years (or less).

Slide # 73

How do you balance capital needs?

1. Examine your current “Work Plan”.
2. What % of the total dollars in the “Work Plan” are directed toward aging plant problems?
3. In a “Work Plan”, the only thing typically addressed is pole replacement.
4. After you have quantified the extent of the problem, you can determine the timeframe in which remedies have to be made and, therefore, how much capital needs to be aimed toward this project on a yearly basis.

Slide # 74

How do you balance capital needs?



Compare new investment dollars per consumer in the various areas of the system or by substation.

Depending upon the age and condition of your system, do not be surprised to find that 10% to 30% of your total distribution yearly budget should be earmarked for aging plant problems.

Slide # 75

In Summary



1. Quantify your system's problems.
All systems vary.
2. Develop or list all known problems.
Update this list yearly.
3. Quantify the remedies in dollars,
man-hours, etc.

Slide # 76

In Summary (continued)



4. Prioritize the remedies based upon the criteria we have discussed during this presentation.
5. Budget funds for the highest priority items.
6. Construct the facilities as planned.
7. Update the “List” and re-prioritize and re-budget yearly.

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

**Composite Conductor (ACCR):
High Capacity Upgrades of Existing
Transmission Lines**

**Doug Johnson
Product Development Specialist
3M**

BIOGRAPHICAL SKETCH

Doug Johnson

Mr. Johnson is a graduate of the University of Minnesota where he studied Physics, Economics and did graduate studies at Cornell University. Doug joined the Metal Matrix composite group at 3M in 1992 working on developing high strength ceramic fibers and metal matrix composites. He is one of the original developers of 3M's composite conductor. As a product development specialist at Doug leads the composite conductor applications group at 3M and is responsible for composite conductor design and application, economics in transmission systems. Doug has most recently been involved installations of the composite conductor in Minnesota, North Dakota, Arizona, California and other locations in the US.

The Composite Conductor



Doug Johnson

Energy Markets
3M Industrial Business

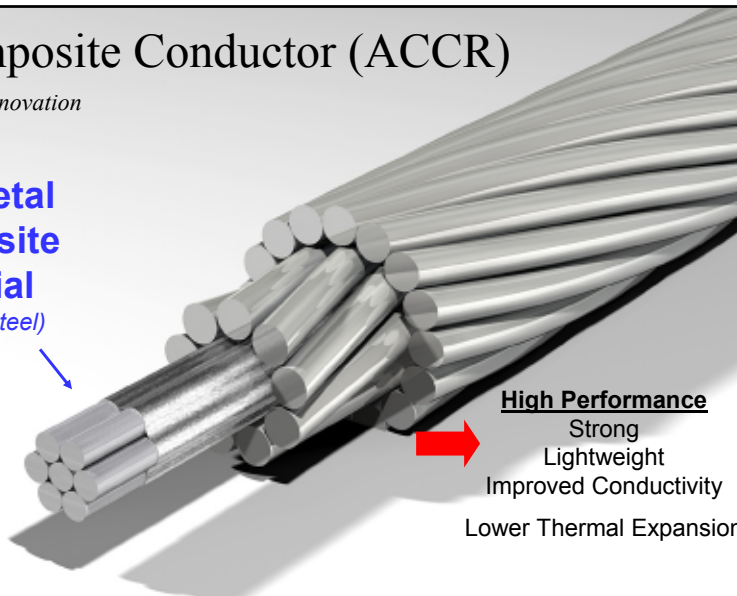
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3M *Innovation*

3M Composite Conductor (ACCR)

A Materials Innovation

**New Metal
Composite
Material**
(replaces steel)



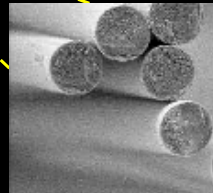
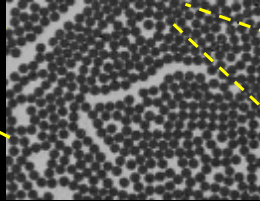
High Performance
Strong
Lightweight
Improved Conductivity
Lower Thermal Expansion

**Quick solution to increase capacity of existing
transmission lines without need for new towers or a
visual change to line**

Developed for Performance and Reliability



Metal Matrix
Composite (inorganic)

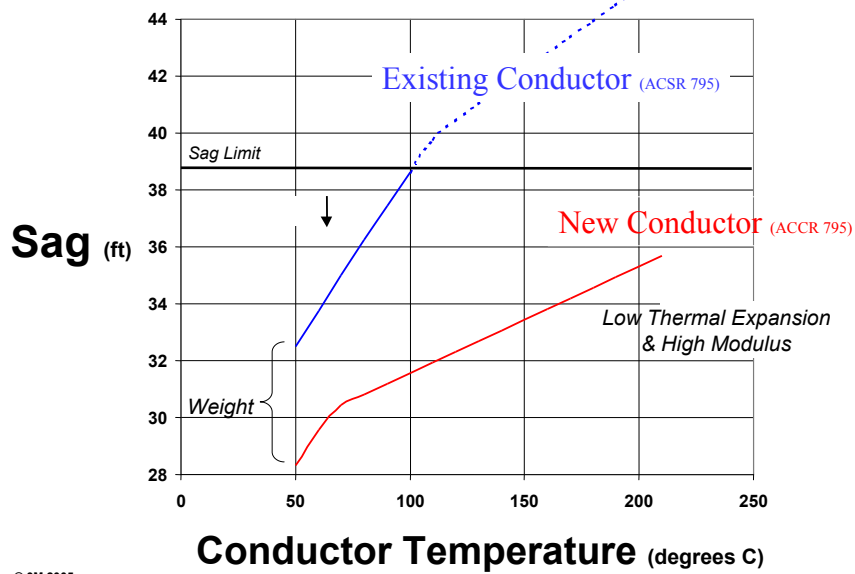


Aluminum-Oxide Fibers

Key Features:

- Improved properties
- Chemically compatible materials (stable)
- Fully hard aluminum
- Redundancy on strength (load sharing and construction)
- Safety factor on temperature

How It Works...



Thermal Expansion

Short Circuit

Torsional Ductility

Drop Test

Strength Stress-strain

Axial Impact

High Temperature testing

Shotgun

Galloping



Alcoa Fujikura Ltd.



Stockbridge Dampers



Full-Tension Joints



Bolted
Comealongs



Bolted Parallel
Groove Clamp



Dead-end Hardware



Jumper Connectors



Repair Sleeves



Terminal Connectors



Conductor Accessories

© 3M 2005



Conductor Testing	477	795	1272	596TW	675TW	774(46/37)
Tensile Strength	✓	✓	✓	✓	✓	✓
Stress-Strain Curves	✓	✓	✓	✓	✓	✓
RT Creep	✓	✓	✓	n/a	n/a	
ET Creep	✓	n/a	n/a	n/a	n/a	
Impact	✓	✓	n/a	n/a	n/a	
Crush	✓	✓	n/a	n/a	n/a	
Torsion	✓	✓	n/a	n/a	n/a	✓
CTE	✓	✓	n/a	n/a	n/a	
Core strain f(T,S)	✓	n/a	n/a	n/a	n/a	
DC Resistance	✓	✓	✓	✓		✓
Fault Current	✓	✓	n/a	✓	n/a	active
Lightning Strike	✓	✓	n/a	n/a	n/a	
Aeolian Vibration	✓	✓	✓	✓	n/a	2005
Sag	✓	✓	active	✓	✓	2005
Corrosion	n/a	✓	n/a	n/a	n/a	n/a
Sheave	active	✓	active	active		active
Post-field test	✓	2005	2005		✓	

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Accessory Testing	477	795	1272	596TW	675TW	774
Alcoa						46/37
DE Strength	✓	✓	✓	✓	✓	✓
Joint Strength	✓	✓	✓	✓	✓	2005
RT Sustained Load DE + Joint	✓	✓	✓	✓	✓	2005
ET Sustained Load DE + Joint	✓	✓	✓	✓	✓	2005
Current Cycle	✓	✓	✓	✓	n/a	
Dampers	✓	✓	✓	✓	n/a	✓
Repair Sleeve	✓	active	active			
PLP						
DE Strength	✓	✓	✓	n/a	✓	active
Joint Strength	✓	✓	✓		✓	
RT Sustained Load DE + Joint	✓	✓	✓		active	2005
ET Sustained Load DE + Joint	✓	✓	✓		✓	
Current Cycle	active	✓	✓			
Suspension - turn angle	✓	✓	n/a	n/a	n/a	2005
Suspension - unbalanced load	✓	✓	✓	✓	n/a	2005
Suspension - ET profile	✓	✓	✓	✓	n/a	2005
Galloping	✓	✓	✓	✓	n/a	2005
Aeolian Vibration	✓	✓	✓	✓	n/a	2005
Corona RIV	✓	✓				
Spacer		active				
Repair Splice	✓	✓			active	
Post –field hi-temp	✓	2005	2005		✓	

High Temperature Testing

(210°C-continuous, 240°C-emergency)

Conductor

thermal expand

fault current

sag

thermal cycles

sustained current

Accessories

current cycle

thermal profile

sustained load

thermal cycles

sustained current

Core

strength

aging

creep

thermal cycle

thermal expand

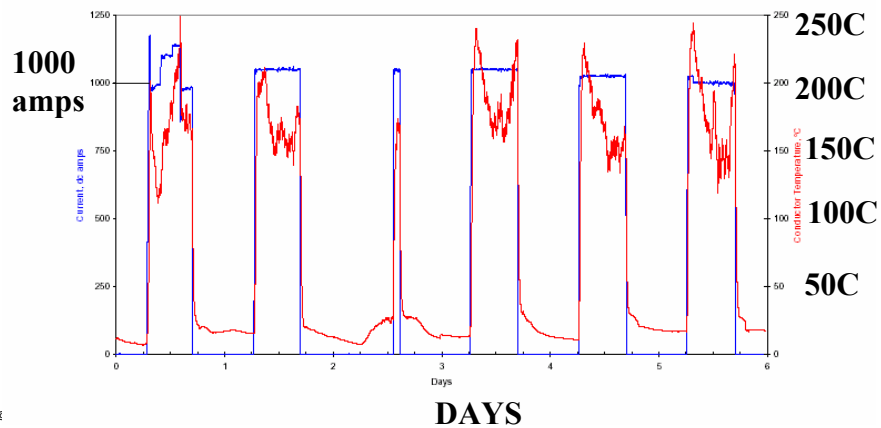
Al-Zr

aging

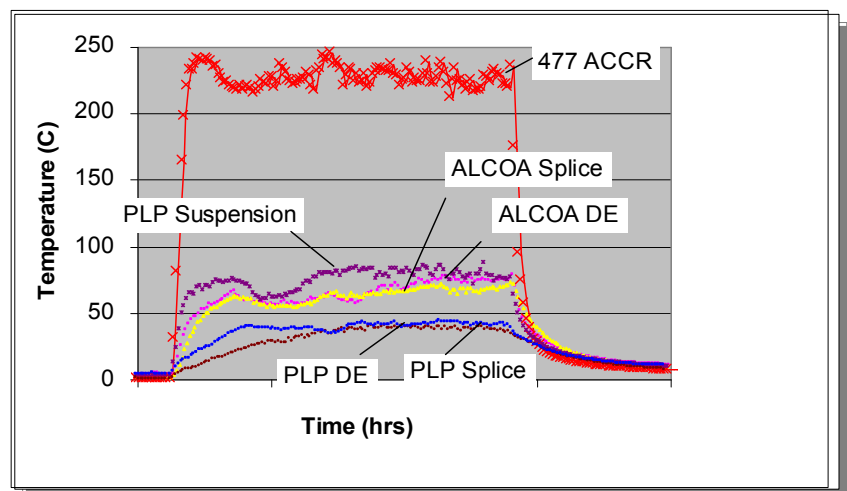
resistance

Over 100 CYCLES to 240C (464 F) (477 ACCR)

Fig. 1. Current and temperature profile for the 6 days of testing.



Accessories Operate < 80 C when Conductor is fully loaded



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Field Installations



46kV Hawaii
2002



230kV North Dakota
2002



115kV Minnesota
2001



© 3M 2005
ORNL Tennessee
2002



230 kV Phoenix
2004

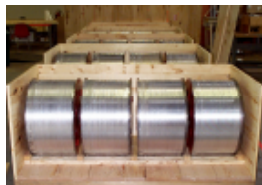


69kV Phoenix
2004



115kV Columbia River
2004

Available from 3M as total package



3



- Conductor & Accessories
- Installation Guidelines
- Laboratory Test Results
- Technical Support

ACCR

Technical Documentation

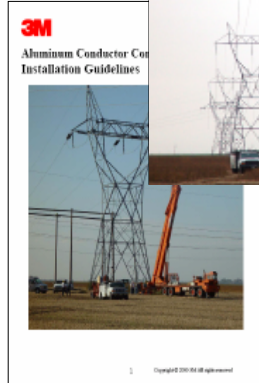
www.3M.com/ACCR



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Technical Documentation
 Aluminum Conductor Composite Reinforced
 3M
 Aluminum Conductor Composite Reinforced
 Installation Guidelines
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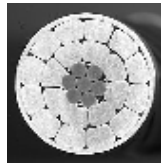
Technical Documentation
 Aluminum Conductor Composite Reinforced
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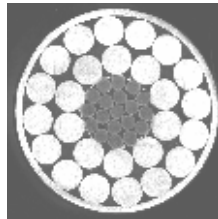
3Composite Conductor



ACCR 477

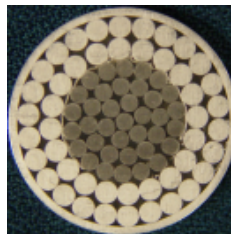


ACCR 675TW

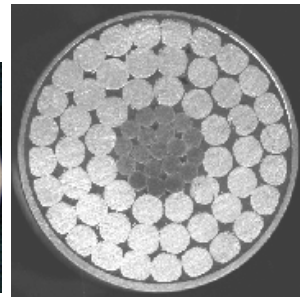


ACCR 795

Unique Families of Conductors
 -Full cable testing per family
 -Full accessory testing per family




ACCR 46/37 774



ACCR 1272

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Primary Application is Thermal Upgrades

- 2X to 3X gain in ampacity
- Existing structures
- Quick and simple solution
- Minimal environmental impact
- No visual change
- Cost competitive vs. rebuild

Thermal Upgrade Application Guide

Competitive Performance: **AVOIDING REBUILDS**

Replacement ACCR	Ampacity ACCR	Capacity Increase (x times ACSR)		Equiv. ACSR Line
kcmil	amps	min	max	kcmils
336	937	1.6	3.1	636
397	1,046	1.6	3.1	795
477	1,179	1.6	3.1	1,033
795	1,653	1.6	3.3	1,590
1033	1,940	1.7	3.4	2 X 636
1272	2,229	1.7	3.5	2 X 954
1590	2,586	1.7	3.5	2 X 1113

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Applications



Xcel Installation (Completed in 11 months)

- Plant expansion was \$100M investment
- Wetlands
- Challenging timelines



Variety of Urban Terrain Types

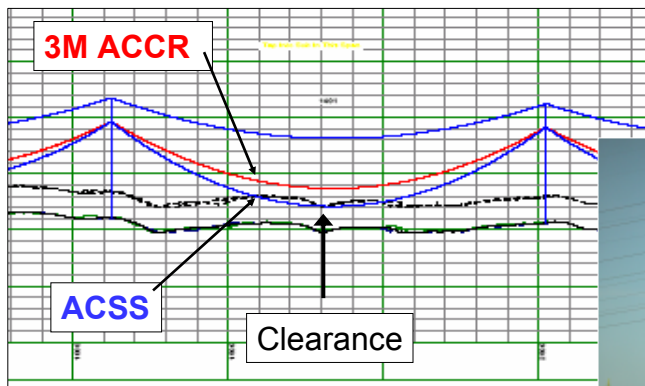
(Presented Permitting Challenges)



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3M Solution Avoided Tower Replacement



Saved the towers in sensitive wetland areas



Supplied 33 Miles
Of ACCR 795



© 3M 2005

Simpler and Faster Than Rebuilding (Eight week installation)



No bucket truck access

© 3M 2005

Lake Crossing



ATV access only



Increased Capacity Without Environmental Impact or Visual Change to the Line

Energized June, 2005 (10 circuit miles)

- Significant increase in current capacity
- Met schedule
- Preserved sensitive wetland environment
- No disturbance to residential areas
- Cost effective



Before

After Installing
3M ACCR

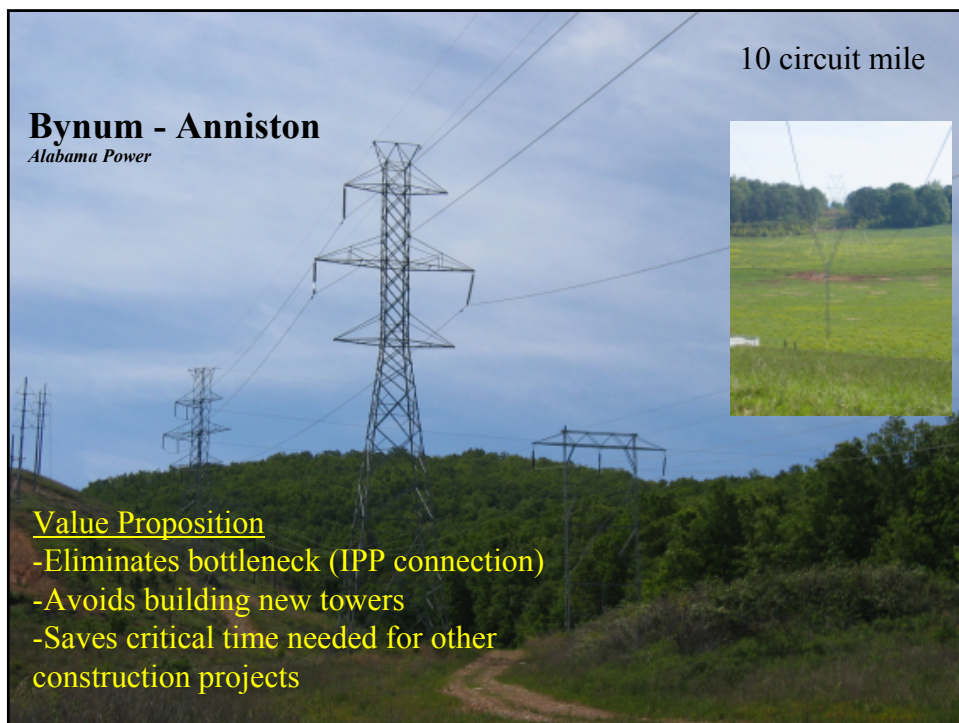
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Topock – Davis – Mead Expansion
230 kV transmission line upgrade for the Western Area Power Administration

80 Mile Line (240 miles ACCR)
Phase 1: 67 miles ACCR
Phase 2: 180 miles ACCR

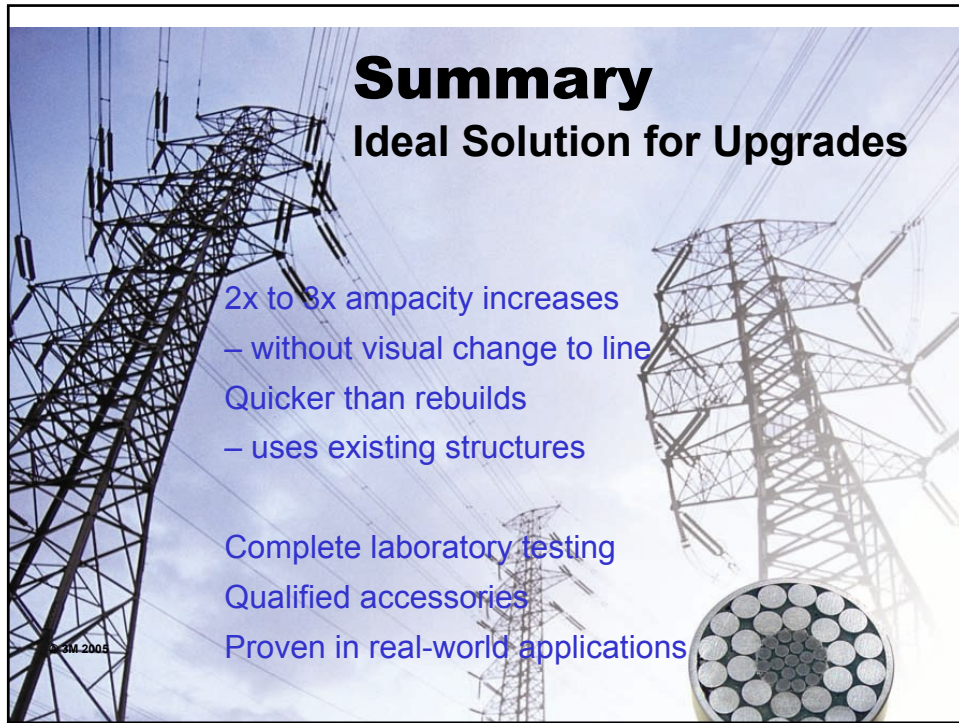
Value Proposition
-Eliminates Bottleneck
-Less Expensive Than Building New TL
-Endangered Species
-Simpler & Faster Permitting



Bynum - Anniston
Alabama Power

10 circuit mile

Value Proposition
-Eliminates bottleneck (IPP connection)
-Avoids building new towers
-Saves critical time needed for other construction projects



Summary

Ideal Solution for Upgrades

- 2x to 3x ampacity increases
 - without visual change to line
- Quicker than rebuilds
 - uses existing structures
- Complete laboratory testing
- Qualified accessories
- Proven in real-world applications

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**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

Anaerobic Digester

**John M. McWilliams, MBA, PE
Resource Planner
Dairyland Power Cooperative**

BIOGRAPHICAL SKETCH

John M. McWilliams

John McWilliams is Dairyland Power Cooperative's Resource Planner. John oversees Dairyland's energy forecasts and resource planning. A major focus of his work is renewable energy generation planning. He joined Dairyland Power Cooperative in July 1999 after previously working for Westinghouse Electric as a field service engineer on construction projects in Iowa, Saudi Arabia and Texas and working for AVO International as a Regional Technical Sales Manager in Texas, Malaysia and England. He has a bachelor degree in electrical engineering from Iowa State University and a master's degree in business administration from the University of Wisconsin – La Crosse. He is a registered professional engineer in Wisconsin and a member of the Institute of Electrical and Electronic Engineers.



RUS 2006 Electric Engineering Seminar

Wednesday, Feb. 15, 2006
Orlando, Florida



Anaerobic Digester

John M. McWilliams, MBA, PE
Resource Planner



Dairyland Power Cooperative

- Provides wholesale electricity for 25 member cooperatives and 20 municipals, who in turn provide the energy needs of over a half-million people
- Service area covers 62 counties in four states – Wisconsin, Minnesota, Iowa and Illinois



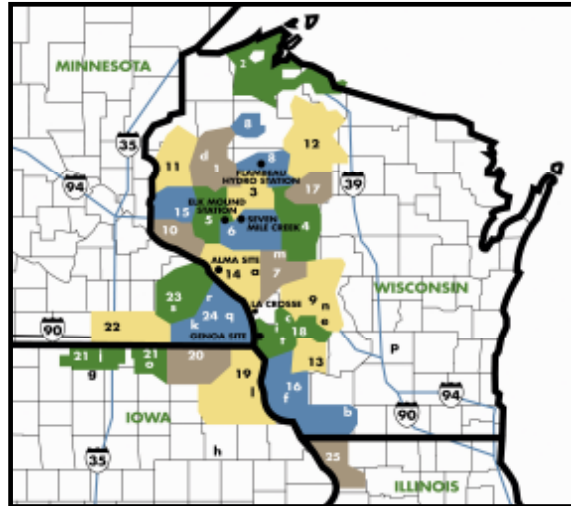
Quick Facts



- Based in La Crosse
- Formed Dec. 1941
- 1,102 MW Generation
- 3,128 Miles of Transmission Lines
- 250 Substations
- 570 Employees



Dairyland Power Cooperative System



DAIRYLAND POWER
COOPERATIVE

Renewable Energy

Standards, Objectives, Options and
Goals

DAIRYLAND POWER
COOPERATIVE

A Touchstone Energy® Cooperative

Wisconsin

- Wisconsin's renewable portfolio standard (RPS) became effective October 27, 1999, making Wisconsin the first state to have a RPS in advance of retail competition. The schedule of the percentage of renewables required and compliance dates are as follows:

0.50% by 12/31/2001
0.85% by 12/31/2003
1.20% by 12/31/2005
1.55% by 12/31/2007
1.90% by 12/31/2009
2.20% by 12/31/2011

Qualifying renewables include fuel cells that use renewable fuels, tidal or wave action, solar thermal electric and photovoltaic energy, wind power, geothermal electric, biomass, and hydro power (less than 60 MW).

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=W105R&state=W1&CurrentPageID=1



Wisconsin Task Force Recommends Increasing Efficiency, Renewable Energy

- At a press conference at the capitol on July 20, Wisconsin Governor Jim Doyle accepted the unanimous recommendations of his Task Force on Energy Efficiency and Renewables.
- The most important recommendations include:
 - Increase the statewide use of renewable energy by all customers to 10% by 2015.
 - Create rural energy initiatives like increased use of locally developed anaerobic digesters and wind generators.

http://www.eere.energy.gov/state_energy_program/news_detail.cfm/news_id=9305



Minnesota

- Beginning in 2005, at least 1% of the electric energy provided to retail customers should be generated by eligible energy technologies. This amount will be increased by 1% each year until 2015, at which time 10% of electricity should be generated by eligible renewables. At least 0.5% of Minnesota's commercial electricity should be generated by biomass energy technologies by 2010, and 1% by biomass by 2015.

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=MN07R&state=MN&CurrentPageID=1



Mndaily.com – January 26, 2005

- “Governor Pawlenty expressed his support for renewable energy in last week’s State of the State address when he said, “Let’s make Minnesota the Saudi Arabia of renewable fuels”.



Iowa

- Beginning January 1, 2004, all electric utilities operating in Iowa, including those not rate-regulated by the Iowa Utilities Board (IUB), are required to offer green power options to their customers. The resulting green power programs will allow customers to make contributions to support the development of renewable energy sources in Iowa. The IUB will adopt rules to implement the statute. Utilities must then file program plans and tariff schedules with the IUB.

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=IA03R&state=IA&CurrentPageID=1



DesMoinesRegister.com January 27, 2005

- "Iowa law requires utilities to get 2 percent of their electricity from renewable sources. Governor Vilsack has a goal of 1,000 megawatts of renewable energy in Iowa by 2010."



Illinois

- In June 2001, Illinois enacted legislation creating the Illinois Resource Development and Energy Security Act. The legislation adopted a statewide renewable energy goal of at least 5% of total energy by 2010, and at least 15% by 2020. However, the legislation does not include an implementation schedule, compliance verification, or credit trading provisions.

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=IL04R&state=IL&CurrentPageID=1



The Times-Press February 11, 2005

- “By 2012, Governor Blagojevich wants renewable energy to make up 8 percent of the electricity sold in the state and he wants the bulk of it to come from wind power. It would be enough to power 1 million homes and that will be important as electric consumption grows, he said.”



Renewable Energy Targets

- Wisconsin
 - Renewable Portfolio Standard
- Minnesota
 - Non-mandated Renewable Energy Objective
- Iowa
 - Mandatory Utility Green Power Option
- Illinois
 - Renewables Portfolio Goal



Renewable Energy Resources



Wind
Projects



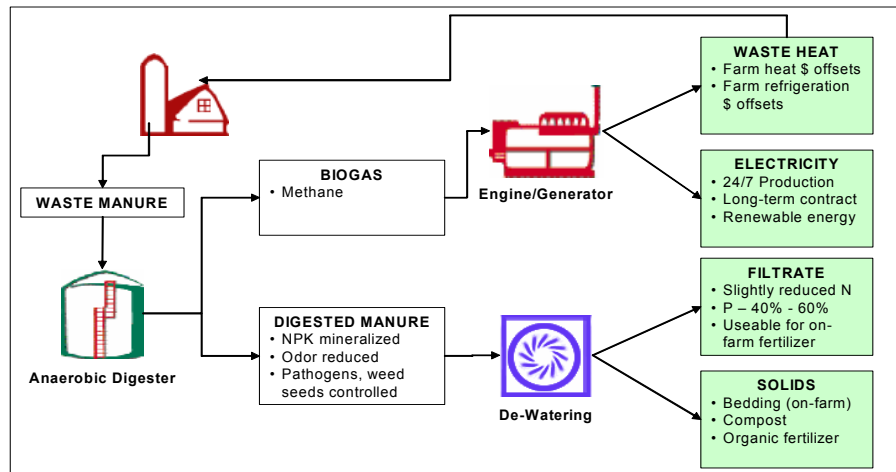
Waste-to-
Energy Systems
(Manure
Digesters)



Landfill Gas-to-
Energy Projects

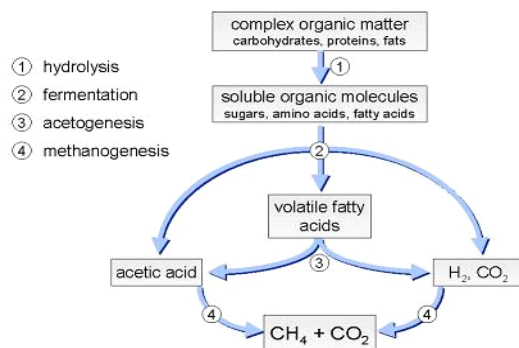


Manure-to-Energy System



DAIRYLAND POWER
COOPERATIVE

Anaerobic Digestion 101



DAIRYLAND POWER
COOPERATIVE

Methane Digester Projects

- Manure Digesters

- Five Star Dairy - Elk Mound, WI
- Wild Rose - LaFarge, WI
- Daley Dairy - Pine Island, MN
- Bach Farms - Dorchester, WI
- Norswiss Farms - Rice Lake, WI

- 0.775 MW each
- 6,000 MWh each annually



DAIRYLAND POWER
COOPERATIVE

September 20, 2004



Digester tank and substrate tank

DAIRYLAND POWER
COOPERATIVE

December 1, 2004



Completed structural work

DAIRYLAND POWER
COOPERATIVE

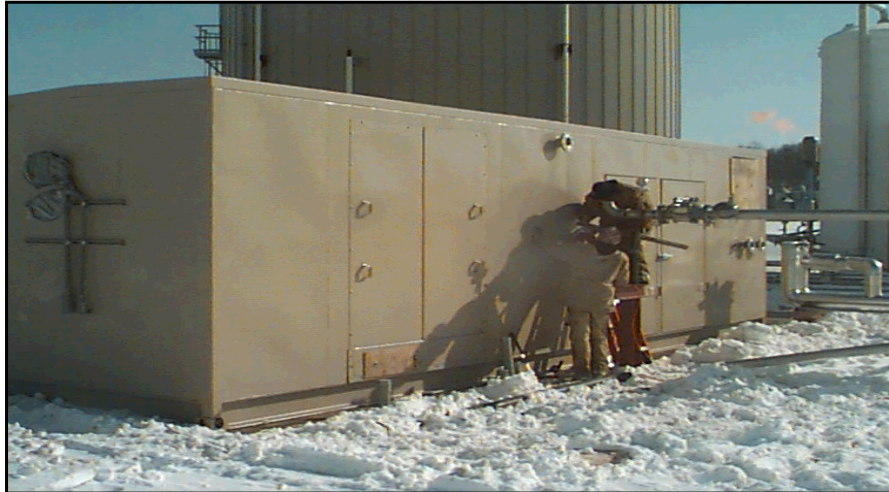
February 22, 2005



Successful production of digester gas

DAIRYLAND POWER
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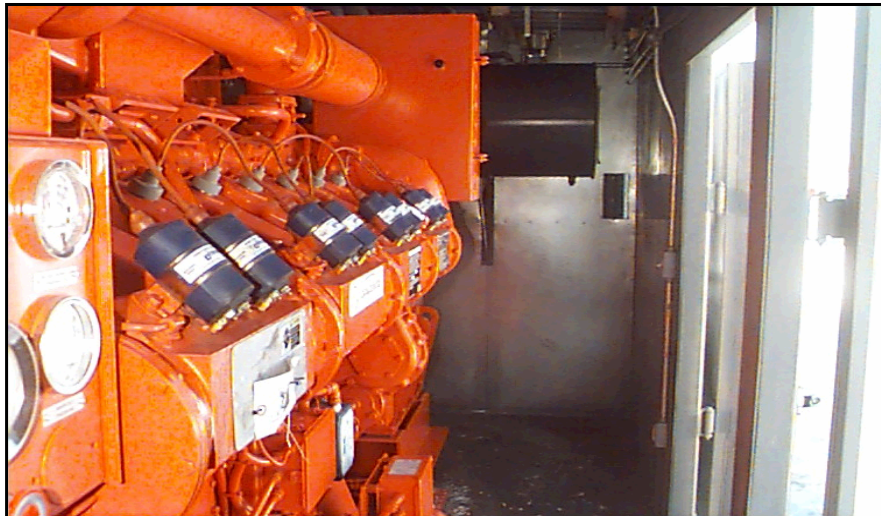
February 22, 2005



Arrival of engine / generator set

DAIRYLAND POWER
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February 22, 2005



775 kW Waukesha engine

DAIRYLAND POWER
COOPERATIVE

June 6, 2005



Arrival of substrate tanker

DAIRYLAND POWER
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Five Star Dairy, Elk Mound, Wisconsin

DAIRYLAND POWER
COOPERATIVE



Five Star Dairy, Elk Mound, Wisconsin

DAIRYLAND POWER
COOPERATIVE



Wild Rose Dairy, La Farge, Wisconsin

DAIRYLAND POWER
COOPERATIVE



Wild Rose Dairy, La Farge, Wisconsin

DAIRYLAND POWER
COOPERATIVE



Norswiss Dairy, Rice Lake, Wisconsin

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Wind Energy

- Chandler Wind Farm
 - 1/3 of the output of the 2 MW farm
 - Approx. 2,200 MWh annually
 - Chandler, Minnesota
- McNeilus Wind Farm
 - 17.4 MW
 - Approx. 48,000 MWh annually
 - Adams, Minnesota
- Tjaden Wind Turbine
 - 0.45 MW
 - Approx. 700 MWh annually
 - Charles City, Iowa

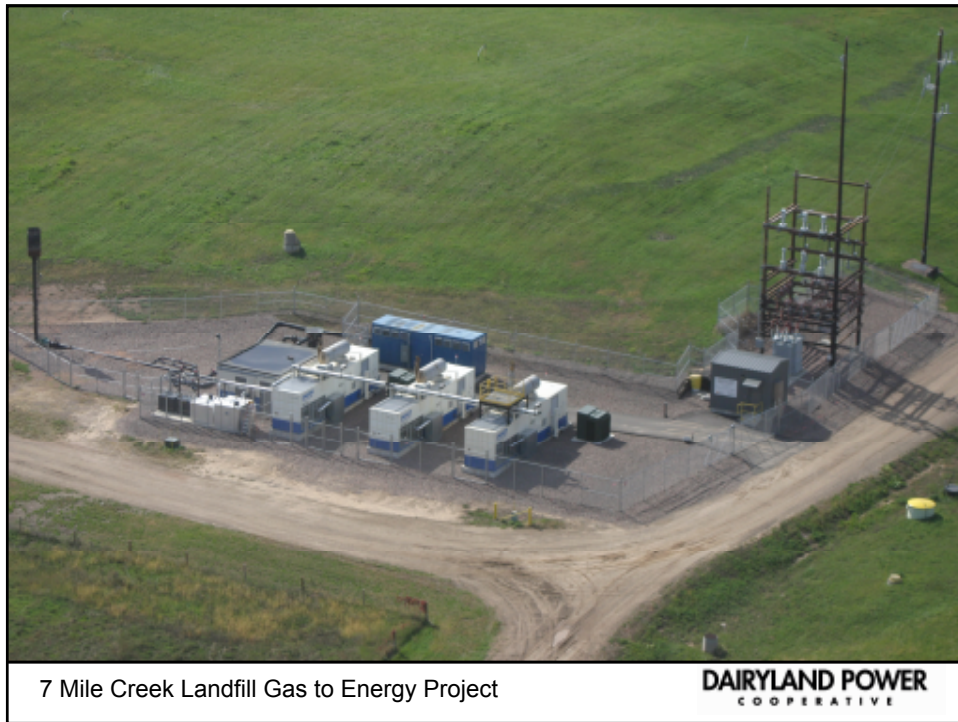


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COOPERATIVE

Landfill Gas to Energy Projects

- 7 Mile Creek Landfill Gas to Energy Project
 - Located near Eau Claire, Wisconsin
 - Three Waukesha engine generators
 - 3 MW
 - 18,180 MWh generated in 2005 at 70% capacity factor
 - Fourth engine to be added in 2006
 - 31,000 MWh annually by 2007

DAIRYLAND POWER
COOPERATIVE



7 Mile Creek Landfill Gas to Energy Project

DAIRYLAND POWER
COOPERATIVE

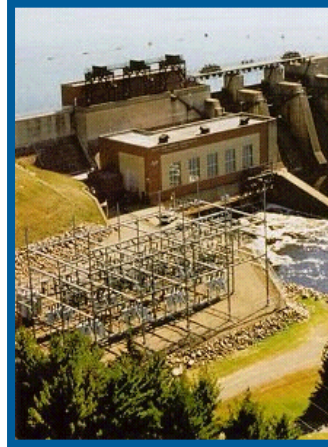
Waste Management Landfill Projects

- Central Disposal Landfill, Lake Mills, Iowa
 - 4.8 MW consisting of six 800 kW Caterpillar engine/generators
 - 38,000 MWh annually
 - On-line in early 2006
- Timberline Trail Landfill, Bruce, Wisconsin
 - 3.2 MW consisting of four 800 kW Caterpillar engine generators
 - 25,000 MWh annually
 - On-line in early 2006

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Flambeau Hydro Station

- 22 MW
- 60,000 MWh annually
- Online 1950
- Relicensed in 2004 by FERC until 2037
- Ladysmith, Wisconsin




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COOPERATIVE

Questions?


DAIRYLAND POWER
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A Touchstone Energy® Cooperative 

**2006 ELECTRIC ENGINEERING
SEMINAR**

FEBRUARY 14-15, 2006

ORLANDO, FL

**Wind Energy in the
Electric Cooperative Sector**

**Robert Putnam, PE
Renewable Energy Technical
Service Manager
CH2M HILL**

BIOGRAPHICAL SKETCH

Robert Putnam

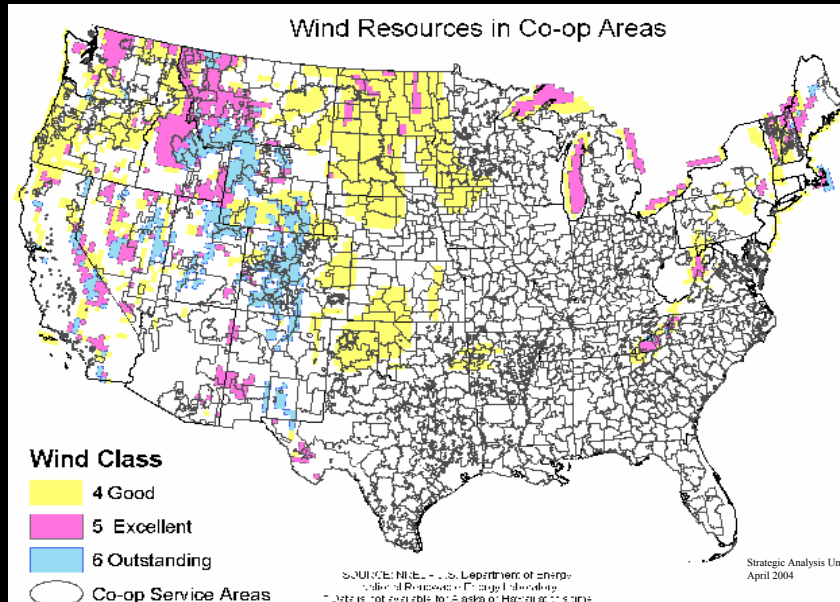
Mr. Putnam manages renewable energy feasibility and transmission studies for CH2M HILL to support project siting decisions and interconnection requests. Bob has 16 years of utility operations and planning experience in the analysis of power and renewable energy systems having worked for Niagara Mohawk Power Corporation/National Grid and the New York ISO, and 11 years of renewable energy consulting experience for domestic and international clients. Bob has served as Executive Director of the Utility Wind Interest Group and Chairman of EPRI's Solar Power Program Committee. Bob has a Master's Degree in Electrical Engineering from Clarkson University and a Masters in Business Administration from Marymount University. Bob is a licensed Professional Engineer in the State of New York.

Wind Energy in the Electric Cooperative Sector



*Robert Putnam, P.E.
Renewable Energy Technical Services
Manager*

CH2M HILL is a Technical Support
Contractor to NRECA



Co-op Wind Power Owners/Purchasers

- Kotzebue Electric Association (AK)
- Alaska Village Electric Cooperative (AK)
- Basin Electric Power Cooperative (ND)
- Minnkota Power Cooperative (ND & MN)
- East River Electric (SD)
- Great River Energy (MN & WI)
- Dairyland Power Cooperative (MN & WI)
- Dakota Electric (MN & WI)
- Salem Electric (OR)
- Orcas Power & Light (WA)
- Holy Cross Energy (CO)
- Yampa Valley Electric Association (CO)
- Tri-State G&T Association (CO)
- Illinois Rural Electric Cooperative (IL)
- Western Farmers Electric Co-op (OK)



Wind Power Benefits and Concerns

Benefits

- No fuel costs
- No emissions
- Low operating costs
- Compatible with other land uses
- Modular construction
- Cost (historically) is coming down

Concerns

- Visual impact
- Wildlife Including Birds/Bats
- Scheduling (intermittent resource)
- Technology risk
- Market risk
- Transmission



2005 - A Record Year for the Wind Industry

- 2,300 MW of Installed Capacity
- Notable Investments
 - *Goldmann Sachs*
 - *Seimens*
 - *Gamesa*
- John Deere promoting wind in the Ag Sector as second crop
- Wind energy getting the attention of the oil & gas industry
- Energy Policy Act (CREBs)



Challenges

- Tight turbine supply
- Higher steel prices
- Inconsistent policy support
- All-requirements contracts
- Small projects are more expensive to implement than large projects



IL REC



Clean Renewable Energy Bonds (CREBs)

- \$300 Million available for rural electric cooperatives
- Issued on a project-by-project basis
- Applications due to IRS by April 26, 2006
- Projects will be allocated the full amount requested beginning with the smallest dollar amount until the total funds are exhausted
- 2-year authorization
- Other potential Co-op funding opportunities include:
 - *Low cost RUS financing*
 - *REPI*
 - *State initiatives*
 - *Farm Bill 9006 Grants and Loans*



NRECA / Wind Powering America Partnership Activities for 2006

- Wind Interconnection Workshop with a focus on cooperative distribution systems held January 19-20. Next workshop tentatively scheduled for late May.
- 4 Webcasts – Next scheduled for April 6 "Wind in a Box" (www.repartners.org)
- Technical assistance (continually available) – Contact Mike Pehosh at NRECA (michael.pehosh@nreca.coop 703-907-5862)
- Regional Workshop (upper Midwest later this Fall)
- Expanded Wind Brief for Electric Cooperatives
- Other resources available through NRECA



NRECA is also Partnering with the U.S. DOE's Geopowering the West Program in 2006

- Geothermal Energy Workshop for Electric Cooperatives
- Support the activities of the Utility Geothermal Working Group
 - *Informational CD*
 - *Web Site*
 - *Annual meeting*
- Technical assistance (continually available) – Contact Bob Gibson at NRECA (bob.gibson@nreca.coop 703.907.5853)
- Guidebook
 - *WebCast series*



CH2M HILL...

Making Technology Work
to Help Our Clients Build a Better World



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**2006 ELECTRIC ENGINEERING
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FEBRUARY 14-15, 2006

ORLANDO, FL

**Grid Interconnection
Issues for Wind Generation**

**Thomas A. Wind, PE
Wind Utility Consulting**

Grid Interconnection Issues for Wind Generation

Tech Advantage 2006
Orlando, Florida
February 15, 2006

By
Thomas A. Wind, PE
Wind Utility Consulting
Jefferson, Iowa

Topics I Will Cover

- What are the key technical and operational interconnection issues?
- What are the electrical and power quality impacts of wind turbines
- Examples of distributed wind generation interconnections and the key issues involved.



Single 900 kW Wind Turbine
Connected to Distribution Line
Near Waverly, Iowa

Key Technical Issues

- Power Quality when connecting to the distribution system
 - Voltage levels during operation
 - Voltage flicker during turbine start up and two-speed generator switching
- Operation of substation and line voltage regulators
- Protecting the distribution grid and wind turbine during grid disturbances.



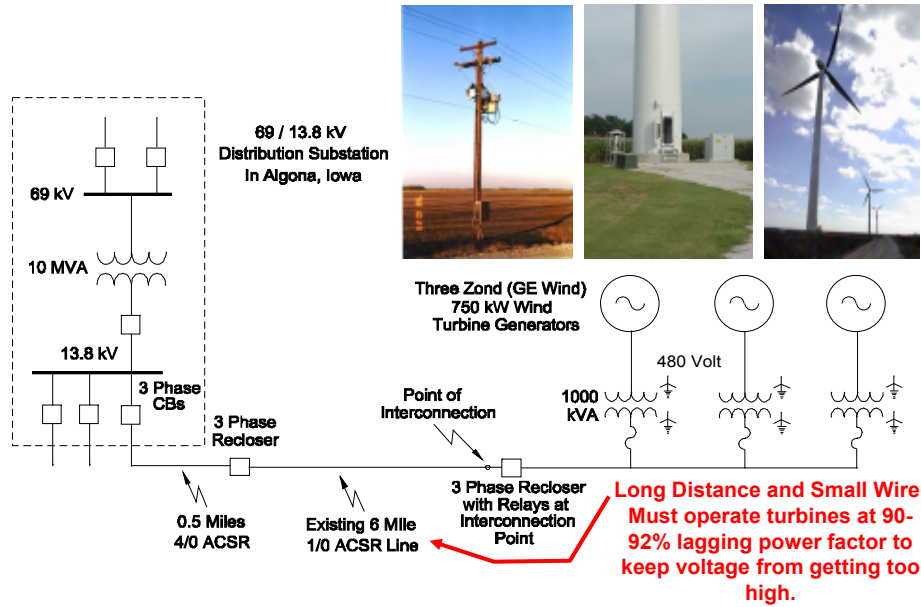
3

Voltage Levels During Operation

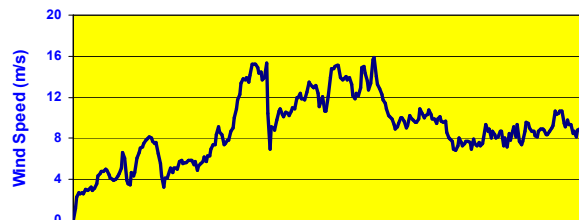
- Voltage levels can rise at the point of interconnection
 - Most pronounced during full generation and light load periods
- For distribution connected wind turbines, voltage levels can exceed design standards out near the wind turbine point of interconnection
 - Especially if the substation bus voltage levels are already near the design limit and during low feeder load periods

4

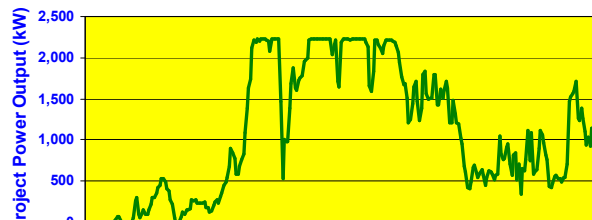
Example of Operating Voltage Level Issue Iowa Distributed Wind Generation Project Near Algona, Iowa



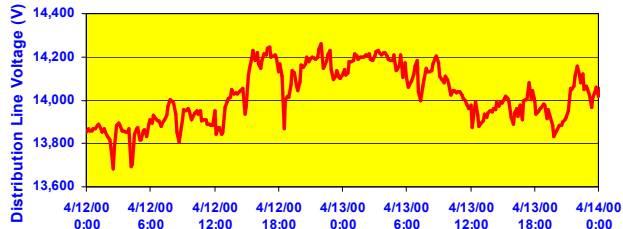
Wind Speed



Power Output



Distribution Line Voltage

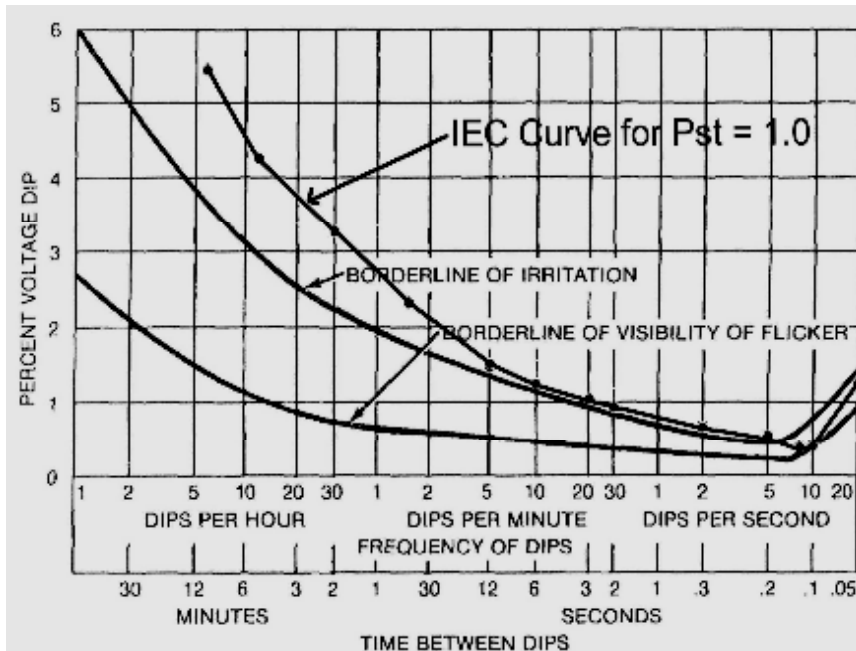


Voltage Flicker From Wind Turbines Connected to the Distribution System

- During generator startup and generator switching, there will be inrush currents which will cause line voltages to dip or flicker
- Voltage flicker may or may not be noticeable or objectionable
 - Depends upon magnitude and how often it occurs
 - Magnitude of flicker depends upon the stiffness of the line
 - Voltage level (4.16 kV, 12.5 kV, etc.)
 - Distance from substation
 - Size of substation transformer
 - Wind turbine electrical design
 - See IEEE Flicker Curve.

7

IEEE & IEC Flicker Curves



Wind Turbine Transient Currents

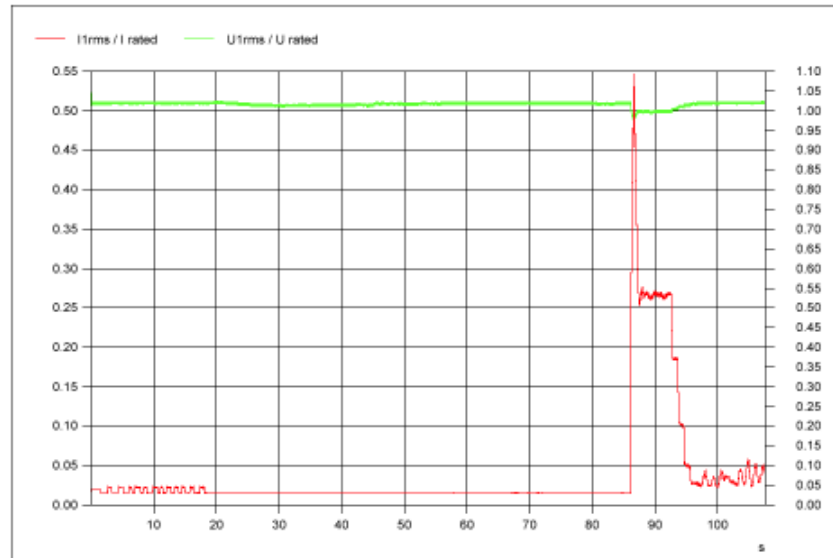


Figure 3.2.5 : Normalised rms-values for current and voltage against time for phase L1

Example of Voltage Flicker Issue



Two 950 kW turbines connected to a 4/0 ACSR rural feeder 2.75 miles from a 69/12.47 kV 7.5 MVA substation by Fairmont, MN

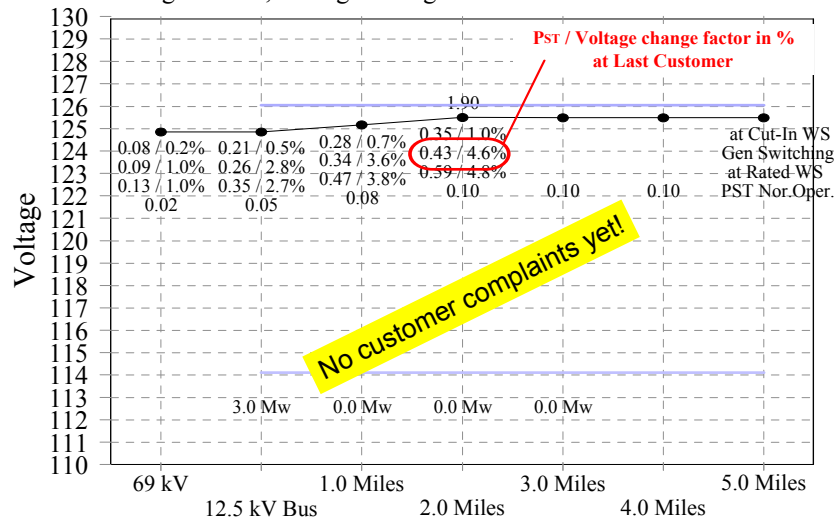
Due to the characteristics of these turbines, voltage flicker was a key design issue.

Two larger 1650 kW wind turbines were added to the same feeder nearby. The worst case scenario (with light and variable winds causing repeated turbine startups) puts the voltage flicker near the design limits (see next slide)

Example of Flicker Evaluation

Proposed Site With 2 NEG-M 950 WTG
NEG-Micon 950 kW with 4/0 ACSR

Voltage Profile, Voltage Change & Flicker Disturbance Factors



For IEC 61400-21 Data Format

Two Projects Where Power Quality Issues Were Very Important Design Issues



Lenox, Iowa

- 750 kW WT
- Very weak grid
- Required a 2 mile long dedicated 4.16 kV UG circuit which tapped a 4.16 kV feeder about 0.25 miles from the substation
- Voltage flicker issues required downsizing the wind turbine to 750 kW



Wall Lake, Iowa

- 660 kW WT
- Connected to a weak 2.4 kV distribution system
- Had to connect directly to the substation bus to avoid voltage flicker issues.



Summary

- For wind projects connected to the distribution system
 - Operating voltage levels and voltage flicker are two factors that will determine where turbines can be placed on the distribution system
- For wind projects connected to the transmission system:
 - Voltage flicker is not an issue
 - Operating voltage levels can occasionally be an issue

**2006 ELECTRIC ENGINEERING
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FEBRUARY 14-15, 2006

ORLANDO, FL

Latest Developments in Photovoltaics

**Kevin Lynn
Senior Research Engineer
Florida Solar Energy Center**

BIOGRAPHICAL SKETCH

Kevin Lynn

Mr. Kevin Lynn is a Senior Research Engineer at the Florida Solar Energy Center (FSEC) and has been working in a faculty position since 1998. Currently he is co-PI on the Southeast Regional Experiment Station, a project with the Department of Energy focused on photovoltaic system research with an annual budget of around \$1 million.

Mr. Lynn began working at FSEC as a graduate student from 1994 to 1997 in mechanical engineering under Dr. Neelkanth Dhere. During that time he worked on novel methods for manufacturing CuInGaSe₂ solar cells using physical vapor deposition. In 1997 he graduated with a Master of Science degree and co-authored several peer-reviewed papers on the subject. He was voted Materials Science student of the year in 1996.

In 1998, he was hired to by FSEC to work with the Caribbean Hotel Association (CHA) and Caribbean Action for Sustainable Tourism (CAST). He developed a one-day seminar to teach stakeholders about photovoltaic applications for hotels such as lighting, disaster relief, remote power, and utility-interactive systems. These seminars were presented throughout the Caribbean.

Since 1999 he has been working in the Photovoltaics and Distributed Generation division. During that time he has published peer-reviewed papers on PV outdoor lighting, stand-alone system testing, utility -interactive systems, and inverter testing. He is a member of IEEE and has been a contributing and voting member on standards for testing stand-alone systems. He has also spent considerable time developing training materials and teaching courses in PV. These include courses for contractors on how to install PV systems as well as courses for code officials on how to properly inspect PV systems installed in the field. He is now re-enrolled at UCF working on is doctorate in Materials Science.



FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence Since 1975

The Latest Developments in Photovoltaics

Kevin Lynn
Senior Research Engineer

February 15, 2006

A Research Institute of the University of Central Florida



FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence Since 1975



A Research Institute of the University of Central Florida





Florida Solar Energy Center



- ❖ Created by the Florida Legislature in 1975
- ❖ **The** energy research institute of the state of Florida
- ❖ A mission of research, testing and education
- ❖ The experience, staff and capabilities to help solve our energy problems and help the U.S. meet our energy needs
- ❖ Began as a “solar energy” center but grew into many new research and development areas.



Photovoltaic Modules





Stand-Alone PV Applications



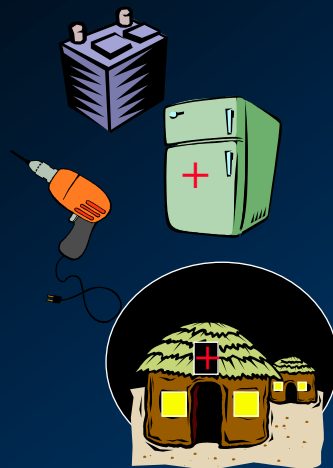
- ❖ Consumer electronics
 - calculators, watches, etc.
 - small battery charging
- ❖ Earth-orbiting satellites
- ❖ Cathodic protection
- ❖ Telecommunications



Stand-Alone PV Applications



- ❖ Village power
 - small machines, lighting, pumping
 - clinics and community centers
- ❖ Health care facilities
 - vaccine refrigerators, lighting, medical equipment

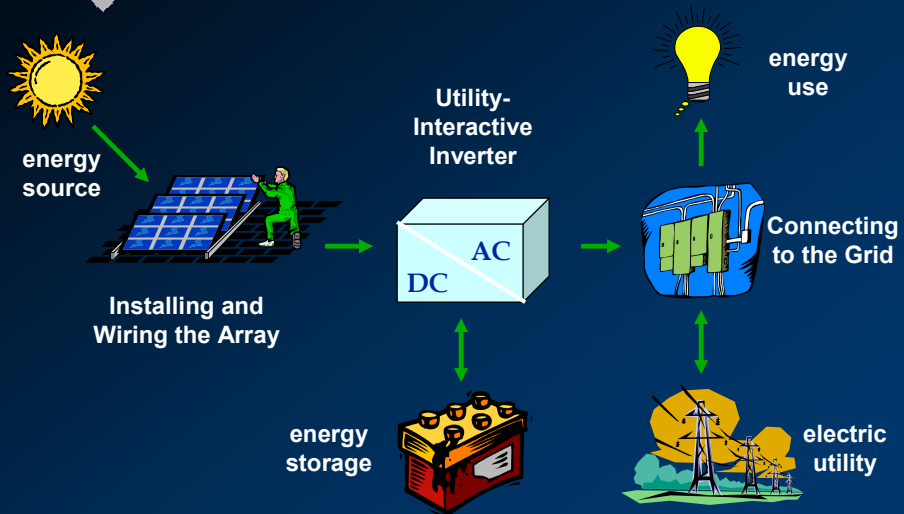




PV Lighting



Grid-Connected PV Systems



Solar for Schools Program



BIPV Modules



Building Integrated Photovoltaics: Sharp Solar
Ladera Beach, CA



BIPV Modules



Building Integrated Modules: GE Gecko Modules

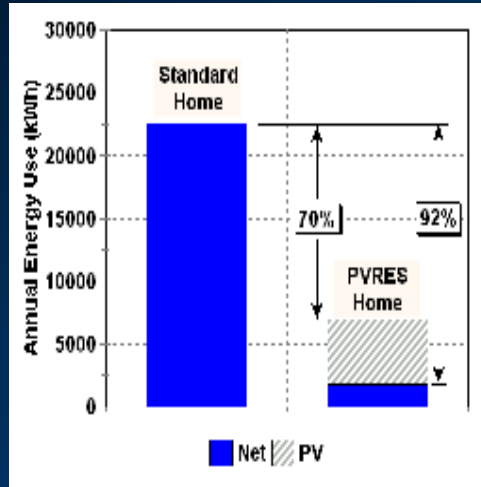


Commercial Systems

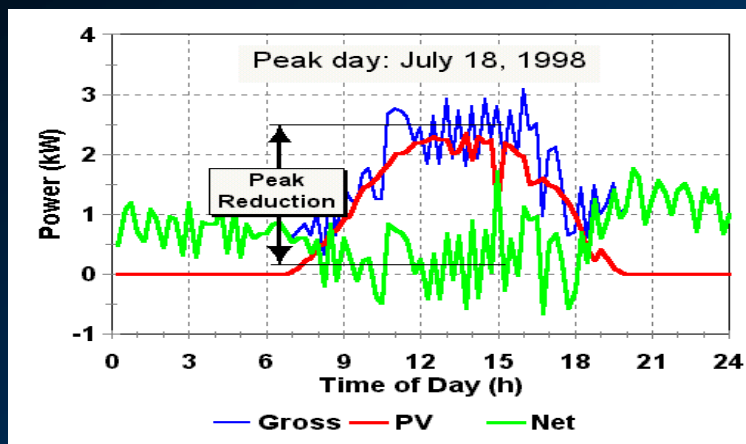




Zero Energy Homes



Zero Energy Homes





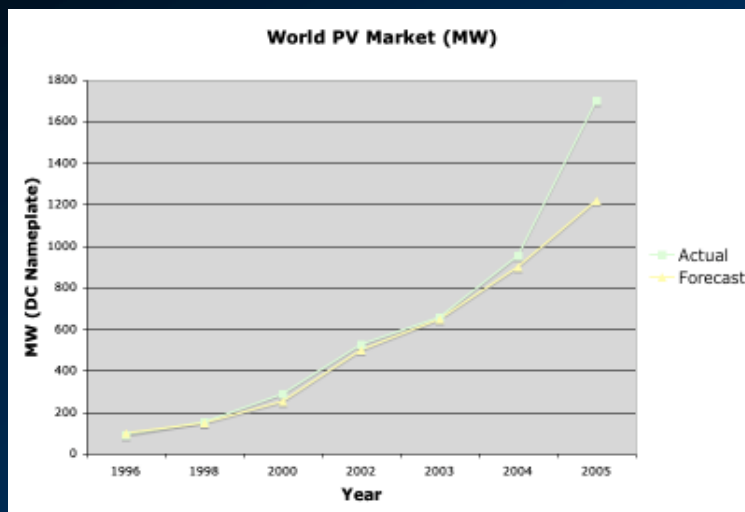
World Markets



- ❖ “Thanks largely to growth of the subsidized grid-connected market in Japan, Germany, and United State of California, 2004 saw global production of photovoltaics.”
 - Paul Maycock, PV News

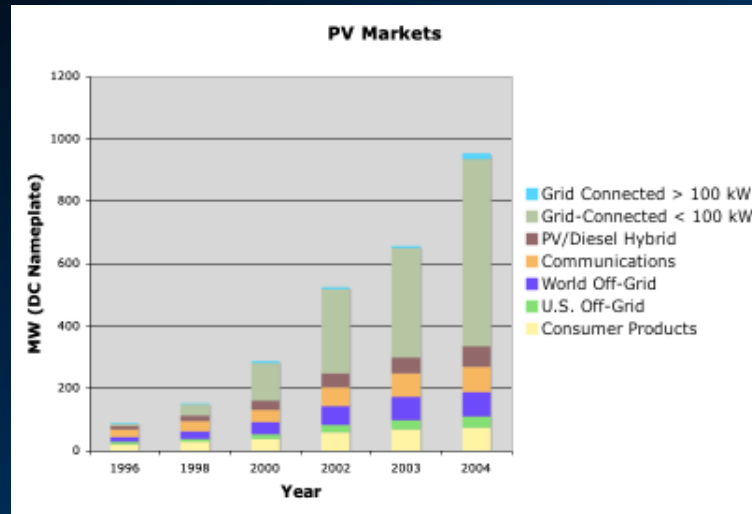


World PV Market





PV Markets



World Markets: Japan



❖ Japanese PV Systems Dissemination Program: 1994-2004

- Goal: Create sustainable markets in Japan through initial government subsidy
- Subsidy in 1994: 50%
- Subsidy in 2004: 6%
- 200,000 systems installed in 10 years
- No subsidy in 2005 and market continues
- Installed cost: \$6/watt



World Markets: Germany



- ❖ Energy Subsidy: € 0.45 - 0.62 /kWh produced
- ❖ Around 300 MW installed in 2004, around 360 MW in 2005



US Markets: California



- ❖ The California Public Utilities Commission unveiled their new Program: California Solar Initiative
 - \$3.2 billion incentive program
 - Install 3,000 MW of solar on 1 million buildings
 - Eleven-year program due to start in early 2007
 - Average Installed costs: \$8/watt
 - Currently around 4000 systems installed

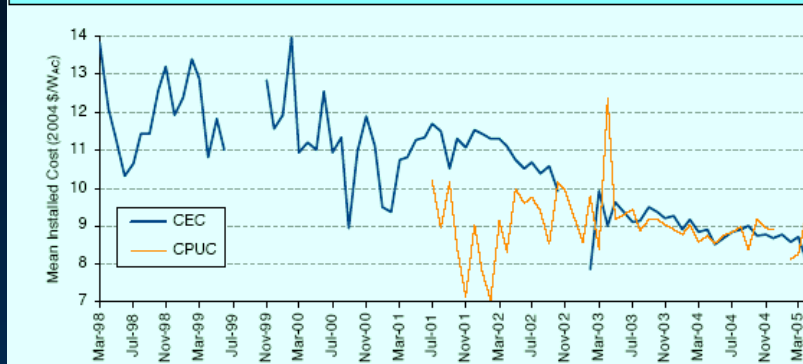


California PV Costs



CEC: Average annual reduction of **\$0.70/W_{AC}** (7.3%/yr)

CPUC: Average annual reduction of **\$0.36/W_{AC}** (4.1%/yr)



Letting the Sun Shine on Solar Costs: Wisner, Bolinger, Cappers, Margolis, Jan 2006.



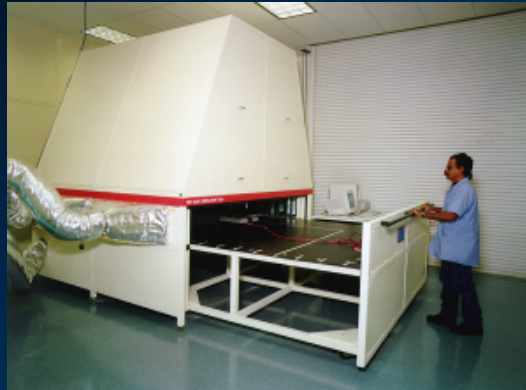
FSEC Capabilities



- ❖ Product Testing
 - PV Module Performance Ratings
 - Inverter Testing
- ❖ Design Review and Approval
- ❖ Training
 - For Contractors and Installers
 - For Code Officials



Module Testing



Spire 660 Sun-Simulator



Inverter Test Facility





Design Review and Approval



- ❖ Packaged System includes
 - Complete Documentation
 - Diagrams
 - Electrical Schematics
 - P.E. Approved Mechanical Installation
 - Appropriately Rated Components
- ❖ Results in simplified and cost-effective system installation



PV Training



PV Installer's Class at FSEC



Code Official Course in Idaho



Thank You



Bailey the Solar Lab

2006 ELECTRIC ENGINEERING SEMINAR

FEBRUARY 14-15, 2006

ORLANDO, FL

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****OR****

Stop ____ [for regular mail]
1400 Independence Avenue SW
Washington DC 20250-____ [Stop]

We also encourage you to visit the Rural Utilities Service's Home Page at:

<http://www.usda.gov/rus/>

For updated information, see: <http://www.usda.gov/rus/electric/contacts>.

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